Concrete

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"Such Work as Our Descendants Will Thank Us For"

B. F. AFFLECK, president of the Universal Portland Cement Co., says he gets a great deal of personal satisfaction out of being in the cement business. Concrete is not a product like clothes, chewing gum or gasoline, that are promptly used up. In talking at the American Concrete Institute banquet he said that with a few negligible exceptions every yard of concrete which has been mixed and placed since the industry began is still, today, serving a useful purpose. Whereupon Mr. Affleck quoted this from Ruskin, familiar but much forgotten, which might often inspire the concrete worker to use even greater effort for permanence:

> When we build, let us think that we build forever. Let it not be for present delight, nor for present use alone. Let it be such work as our descendants will thank us for; and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because we have touched them, and that men will say, as they look upon the labor and the wrought substance of them, "See! This our fathers did for us."

How High Is Up?

THIS magazine still gets letters asking, "Shall I make my concrete 1:4 or 1:5?" Such letters are vastly fewer than they were when this magazine began publication twenty years ago last month (March 1904). We really are making progress. The safe answer, of course, is "1:4." It is better probably that a beginner go bankrupt buying cement than that he be the instrument of bad construction. "Adding a little cement" covers a multitude of errors. Still the question is like those classic queries: "How long is a piece of string?" or "How high is up?" More and more it is apparent that cement, "the magic ingredient" of concrete has a distinguished rival. Brains really are the magic ingredient. The cement is quite dependent on their superior potency.

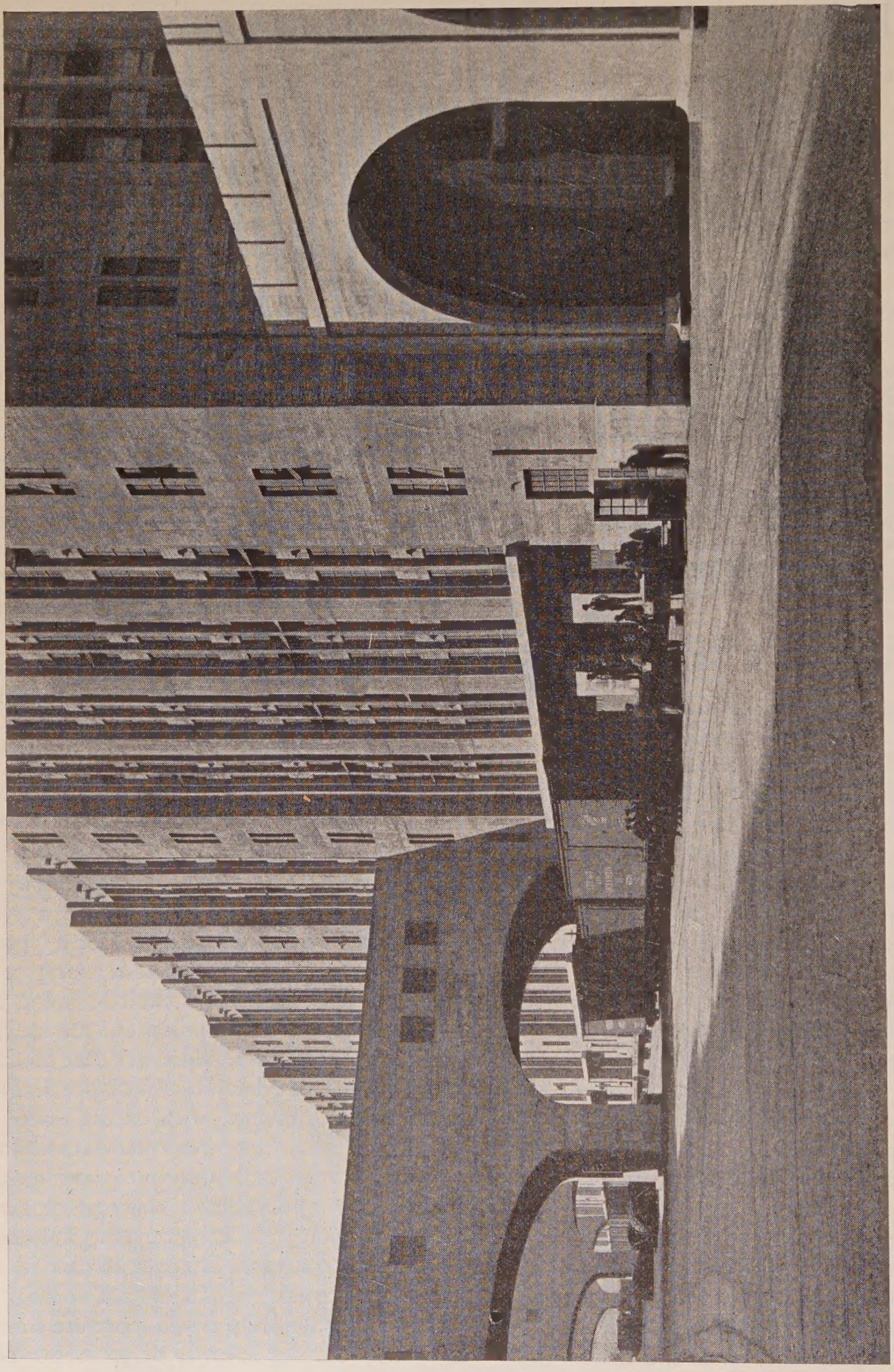
But to the products manufacturer, for instance, just starting out, it proves to be very important in any serious commerical enterprise to know the aggregate. A 1:3 concrete *may* not be so strong or so nearly waterproof as a 1:5 concrete; a 1:8 mix may be better than a 1:5. And unless a products manufacturer can afford the extravagance of throwing away one bag of cement in three, or perhaps one bag in four, he should make the early and intimate acquaintance of the aggregate that is tossed into the mixer with the cement.

The Finest Concrete Architecture

WE BELIEVE we quote Albert Kahn correctly in saying that "Cass Gilbert's Brooklyn Army Base is the finest, frankest expression of reinforced concrete architecture to be found in America." It was immediately after presenting his paper on the development of reinforced concrete building construction in the last twenty years as a part of the American Concrete Institute's twenty year review symposium that Mr. Kahn went into the Institute's exhibit to select such pictures as he recommended for use in setting forth this development when his paper should be published in the Institute's *Proceedings*. His first choice, passing over many fine examples of his own work, was two pictures of the Army Base. So through the courtesy of the Turner Construction Co., which did this outstanding piece of work, CONCRETE this month presents several pictures of the Brooklyn Army Base along with a liberal abstract of Mr. Kahn's paper. The thing which makes the Brooklyn Army Base work notable in reinforced concrete architecture is its utter simplicity and its complete acceptance of the material concrete as one affording an architectural expression of its own.

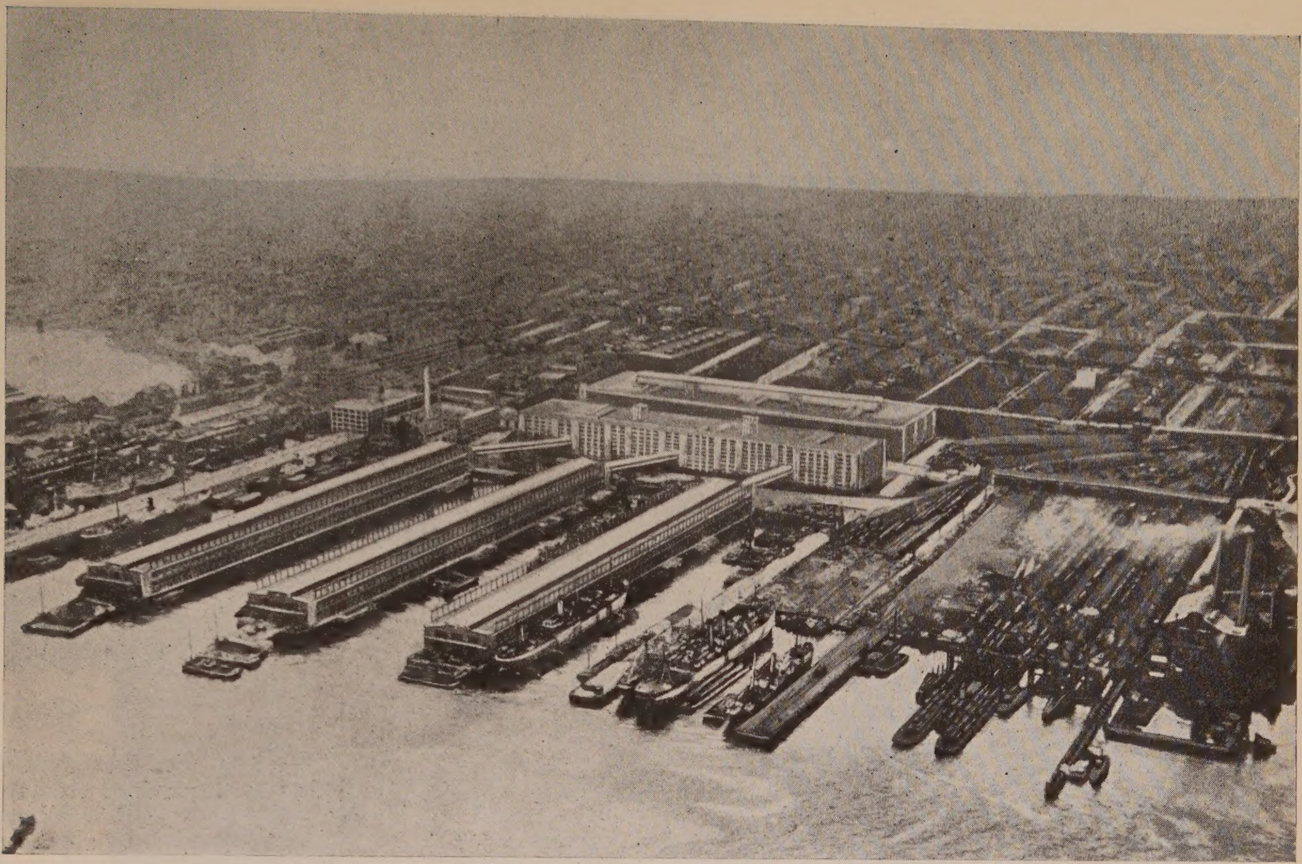
Wet or Dry?

THERE is another question that comes often. The products manufacturer is likely to be a strong partisan. He is either a "dry tamper" or a "poured wetter." He writes: "Which is best, dry tamp or wet cast block?" Usually the answer can't be found until the block themselves are tested unless one can see them made. This much is certain: Most wet cast block are made too wet and most dry tamp block are made too dry. Block can be drowned with excess water and parched with too little. Some can't understand how it is that concrete that *pours* readily into sand molds is of so much higher quality than concrete of similar consistency that is poured in a tight mold. The answer is simple. The excess water in concrete cast in sand molds gets away at once—is filtered out through the molds. The obvious lesson is, if you must use concrete that is altogether too wet in order to get it into place, find some means of getting rid of the excess moisture immediately after it has been placed.



Brooklyn Supply Base, U. S. Army—Cass Gilbert, Architect; Turner Construction Co., Builder

"Cass Gilbert's Brooklyn Army Base is the Finest, Frankest Expression of Reinforced Concrete Architecture to Be Found in America"—Albert Kahn, Architect



Airplane View, U. S. Army Supply Base, Brooklyn, N. Y. Cass Gilbert, Architect

Reinforced Concrete Architecture These Past Twenty Years

By Albert Kahn
Architect, Detroit

Abstracted from a paper presented as part of Symposium on Progress of Concrete Construction in 20 years at 20th Annual Convention, Chicago, February 27, 1924. By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

Much has been done in the field of reinforced concrete in a comparatively short time, both in point of engineering and architectural expression. Unexpected results have been attained, progress has been constant and consistent, but much still remains to be done and undreamed of possibilities will be realities within the lifetime of many present.

Naturally, the early history is full of experiments. That such systems as were exploited at the outset by metal lath, wire fence and cable manufacturers did not result in more failures is inexplicable and miraculous. When we recall the numerous structures erected at the time with floors of 20 ft. and 30 ft. spans of cinder concrete reinforced with cables stretched from wall to wall, the structural design mere guess work, we can only marvel at the protection of a kind Providence and hope that the interior partitions in these buildings may never be removed. Many indeed were the fools who rushed in where angels feared to tread. But fools, men with vision, are necessary in the progress of mankind and were needed in the development of reinforced concrete. Of course there were failures, serious ones, but upon these failures were built the successes that followed.

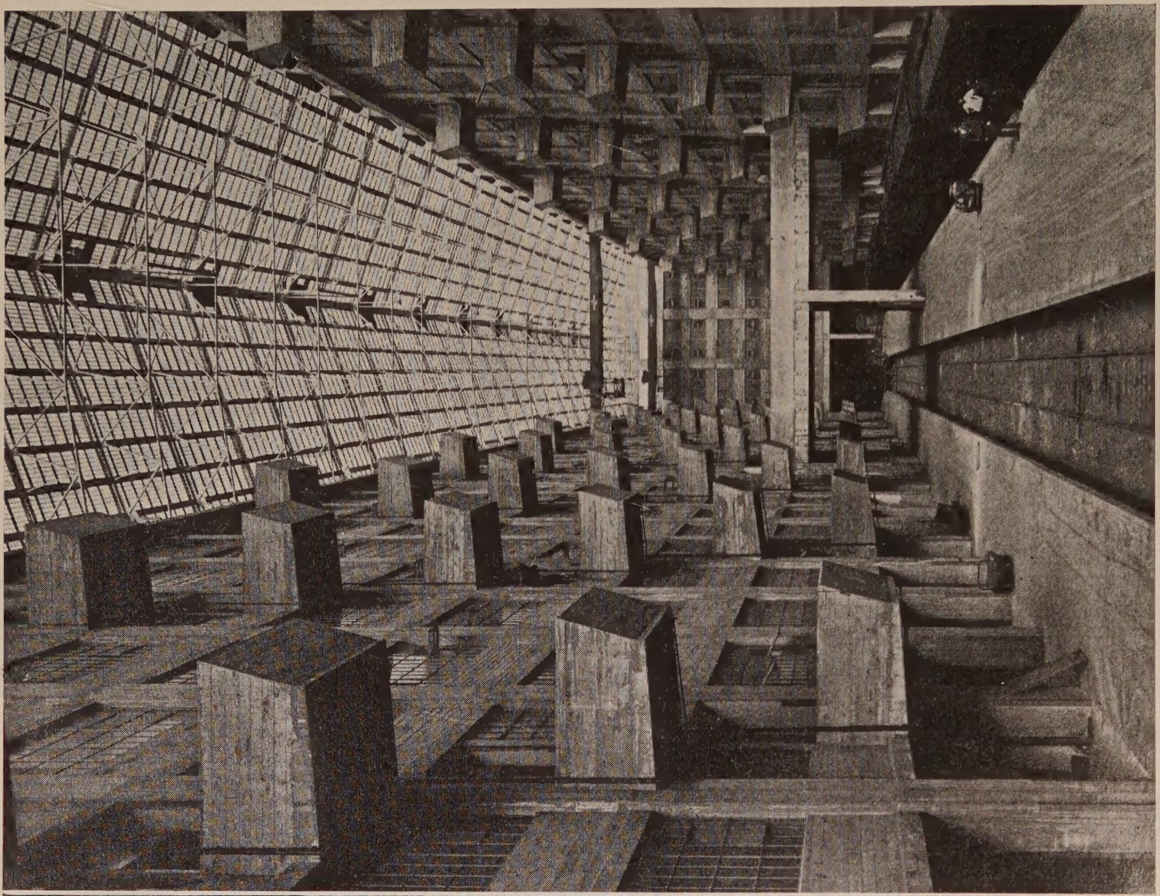
We recall, as with all things new, the serious opposition encountered at the outset, not only from laymen who could not comprehend how a wet mixture of sand, stone and portland cement with a certain number of steel rods placed about could carry its own dead weight, much less heavy live loads, but even more from engineers and architects. Indeed, the chief difficulty was to overcome the resistance and inertia of these professional men who had feelings of doubt and clung tenaciously to the forms of construction with which they were more familiar.

Then there was the opposition of the clay tile industry which with the introduction and development of the new construction feared ruin for itself. Who does not recall the trade journals with glaring accounts of concrete failures and articles predicting the direst happenings?

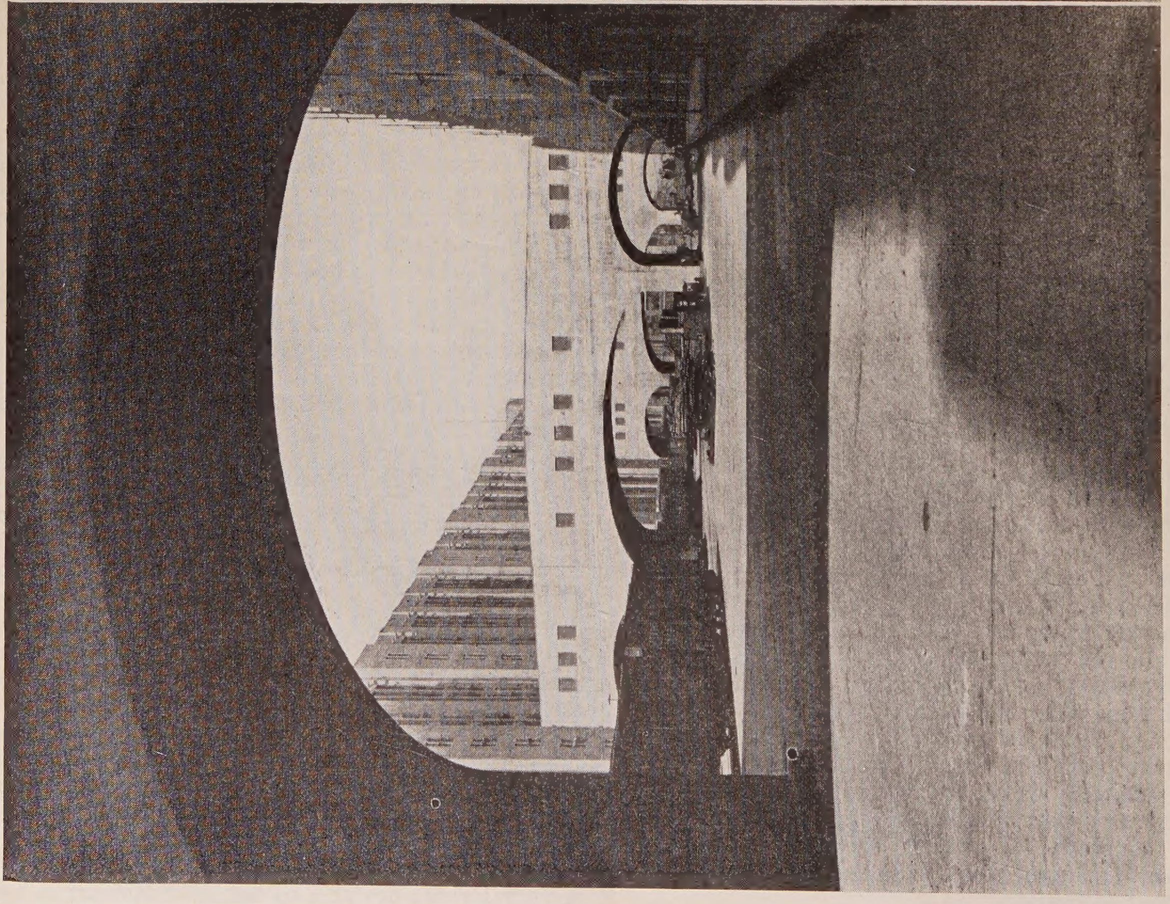
The structural steel interests were no less strenuous in their vilification. They, also, feared heavy inroads upon their product. We well know how ridiculous these onslaughts, now that it has proved that there is need for all, indeed more need than ever for all.

Even the lumber interests combated the advancement of the new construction, but they now find that their material is required in greater quantities than ever. The lumber necessary for form work being no small factor in this increased demand.

A very serious obstacle to the development of rein-



Cantilever Balconies in Craneway for Direct Transfer of Goods From Cars to Warehouse



Connecting Bridges Between Army Supply Base Warehouse and Administration Building

"The Brooklyn Army Supply Base is Truly the Work of an Artist"

forced concrete was no doubt the over-enthusiasm of its early devotees who believing it a panacea, undertook to use it for any and every problem. We have since learned that isolated columns and beams are cheaper and quicker of erection in structural steel fire-proofed, and that long span trusses high up are as a rule more costly and more difficult to construct in reinforced concrete than in structural steel. Some ill-advised undertakings naturally had a retarding effect upon the progress of the art but they were necessary to determine the limitations of the new construction. Today the practical engineer or architect quickly decides which best serves its specific purpose and does not hesitate to use the different materials in combination, to the end of producing the best result, most economically.

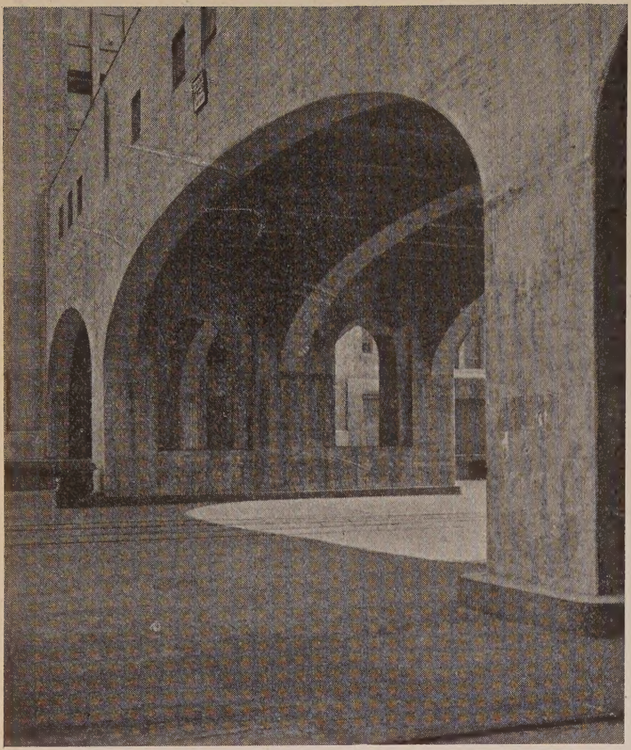
Another hindrance was the lack of authentic data on reinforced concrete. Everybody devised his own method of computation and needless to say no two agreed. As to the methods of constructing form work and when to strike forms were mere guess work and many a mishap was caused by the lack of definite knowledge or information. Out of this chaos there developed a few men who by means of tests and experiments contributed their ideas and results of tests for safe formulae and methods. Monier, Coignet, Considere and Hennebique gave reinforced concrete its real start. Its present highly developed state in this country, however, is due in the largest measure to engineers connected with commercial institutions who possessed the courage and initiative to design and build structures in the more practical methods conceived by them. They were the real pioneers, did the real work, made the mistakes and suffered the consequences. Their errors and resultant losses formed the foundations upon which the theory and practice of reinforced concrete was really established.

Chief among the objections to reinforced concrete was its dead weight and consequent size of the columns. Thereupon were developed the hooped column and the various types of hollow floors.

The introduction of the flat slab system created great consternation in the minds of architects and engineers. How was it to be calculated? It stood up, but how and why? Methods of computation had to be revised and the dependence upon tests was increased. Whatever the extravagant claims made for this by its first advocate, it is one of the most important contributions of America.

History is still in the making. There will be further developments in practice, building laws will be revised

"By a Masterly Vertical Subdivision of Pylons, Piers and Mullions * * * We Have a Work of the Highest Architectural Merit"



"The Architect Made No Attempt to Hide the Board Marks of the Forms"

to take fuller advantage of the potentialities of reinforced concrete, concrete design will grow lighter, more elastic and more economical. Greater knowledge of the subject, better materials, more perfect control and the concerted efforts of the American Concrete Institute will help to bring this about.

As was to be expected, reinforced concrete in the first instances in this country was employed merely in the construction of skeleton frames, much as in steel, with the one difference, that the floors were part and parcel of the frame, which latter made for a more rigid building. The exterior facings were masonry of one kind or another supported by and enclosing this frame.

European architects less familiar with this method of building, employed concrete from the outset for exterior facings. With labor costs much lower, and careful workmanship more general than here, it was only natural that they should produce results quite impossible in this country. Furthermore, the climate in those parts where reinforced concrete was most used was less severe than in most sections here. They, therefore, had a different problem.

Concrete being plastic in its initial state, it was easy to mold it into forms, which were quite impossible with stone or brick, the very facility with which the material could be shaped proving the prime cause of much that is bizarre. The "Nouveau Art" movement was sweeping Europe just at the time and exerted a deleterious influence upon design in general and particularly reinforced concrete which permitted the use of such extraordinary forms. The wildest conceits were foisted upon the public as works of art. Nor has the orgy ended, for "Nouveau Art" has since given way to still more degenerate forms attending the latest and worst of all, the "Ultra Modern" Bolshevist movement. This is amply proved by examination of most of the foreign designs submitted in the competition for the Chicago Tribune Building, many of which are mere travesties. At that, however, much of the pre-war work of German architects is outstandingly good.

In France, where stucco serves so well for exterior work, the use of reinforced concrete naturally grew rapidly. It lent itself especially to the extravagances in which modern French architecture loves to indulge. Whatever the opinion of French architects of their productions, it is well that at least American architects have allowed themselves to be but little influenced thereby.

In Belgium, Italy, and Austria, the French mode of design in reinforced concrete was largely followed, and with results even more flamboyant and queer. The sanest, and certainly the most comprehensive development has been that in the United States. Here the material was first used for purely utilitarian purposes as a means to an end, the latter being fireproof buildings, well lighted at low cost. For industrial buildings especially the new system of construction seemed adapted. The skeleton frame of a material that, unlike steel, required no further covering for protection against weather afforded a maximum glass area so essential in manufacturing buildings; the scheme of slender columns, curtain walls and large surfaces of glass, the rigid vibration-proof, fireproof construction, at a price only slightly more than that of mill, quickly appealed to manufacturers and grew in favor in spite of the early opposition. Even the first efforts without attempt at design produced more attractive results than were common with the old-style factory buildings. Since then our architects' efforts have marked a distinct advance in architecture. There has been created something akin to an individual and characteristic type. Their successes in the main were founded on the age-old principle of employing forms suitable to the material and avoiding forms difficult to execute. Simplicity, honest recognition of what was possible with the new material, direct and frank expression of the problems has been the keynote.

At first there were attempts at imitating other materials, particularly by blocking and forming rustications, complex belt courses and cornices to imitate stone. But use of forms characteristic of other materials and imitation have always proved a failure. In concrete it could be no different. On the other hand, frank appreciation of the limitations, adherence to well established laws of composition and proportion, have ever been the underlying principles of good design. Indeed the very restrictions have often proved the basis of successful work.

Since a reinforced concrete structure is primarily a series of columns, supporting lintels and floors, the most direct external expression would emphasize the vertical element. In most of the best work, therefore, the vertical line predominates, piers of varying sizes extending from the ground straight up, even past the roof line. Good proportion in mass as well as solids and voids, play of light and shade produced by judiciously managed projecting surfaces, restrained use of moldings and ornamentation are prime factors in good design. And so effective have been the results procured by observance of these restrictions, that they have been applied to much modern stone architecture with equal gain in appearance.

Architecture has ever been the recorder of man's progress. This is an age of utilitarianism, of the practical and today's architecture is a manifestation thereof. We do not lack appreciation of the beautiful and there exists the desire to encourage art—but only to the degree that it will not interfere with the chief object, namely—the serving of a particular purpose. Such an aim would hardly seem conducive to the greatest art, and yet, through the efforts of men equal to the task, buildings of architectural excellence, though meeting the day's requirements are not uncommon.

Now let us refer to specific examples calling attention as far as possible to distinguishing characteristics. As already stated, the first reinforced concrete buildings in this country were those constructed for industrial purposes, as a rule a skeleton frame of exposed concrete with voids between columns filled with glass, often extending from floor to ceiling without even panel walls. There is little of architecture in such a structure. A slight attempt at design was introduced by providing the building with some sort of cornice. As before mentioned, other materials were imitated at first, with unfortunate results. Then followed franker acknowledgment of the material, with no attempt at making concrete look like stone. This was an improvement. With the feeling that exposed concrete was unattractive, uninteresting in color and texture, the use of brick and other colorful materials in conjunction with concrete was introduced. Then with the consideration of the building in mass and to relieve the monotony of uniformly spaced columns came the corner pylons to form a proper abutment, occasionally in long fronts, also intermediate pylons to vary the design. Concrete panel walls gave way to such built in brick, often entire portions of the frame were veneered in brick, using the exposed concrete as trimming. There is nothing wrong in such a combination, even though it be camouflage, aesthetic laws to the contrary, notwithstanding. Laws in architecture are much like the 18th amendment. They exist only to be broken, with this one difference, however: Architectural laws can be changed—the amendment, I fear not. All depends on how combinations are used, the expedient considered impossible for the mediocre, is often, in the hands of the expert, the very element of outstanding results.

On the other hand, much excellent work has been done entirely in concrete. Take for example Cass Gilbert's Brooklyn U. S. Army Supply Base building. Nothing could be finer in mass, more straightforward or more direct. It is almost bald in its simplicity, certainly ornamentation plays no part in the design and yet by a masterly vertical sub-division of pylons, piers and mullions, all in proper relation to each other, all splendidly proportioned not only in width and height but also in relative projection, we have a work of the highest architectural merit. Nor has the architect tried to conceal the character of the material. Indeed he frankly accepts it and makes a virtue of what would seem a blemish. He makes no attempt at hiding even the board marks of the forms. Instead he procures a certain texture thereby. Throughout there is revealed a fine appreciation of the material employed and the problem in hand. It is truly the work of an artist and incidentally proof positive that even the plainest structure may be made attractive; furthermore, that the architect is a much needed individual in spite of the contrary opinion of many engineers. Compare Mr. Gilbert's building with another reinforced concrete structure in Brooklyn, one built for the Navy and designed by its own engineers and note the difference.

Another important group for the Navy is its office building in Washington. It is inoffensive but it fails in that its design does not express concrete. It might as well be constructed of brick or stone. Mr. Gilbert's is a concrete structure and could be mistaken for nothing else.

A later example of much interest is the Fletcher Building on Varick St. in New York, by Helmle & Corbett. Though not as characteristic as Mr. Gilbert's Army Supply building, it is yet an important contribution and shows the potentialities of concrete design. There is here an interesting grouping of parts, the vertical treatment properly emphasized and yet held together at base and top and reinforced at the corners to produce an excellent architectural composition, without sacrifice of practical needs. If there be any criticism it might be that the belt course, finials and other details savor of stone design. But the building is so good as to outweigh such minor objections. Incidentally, there has been in this building an attempt at surface treatment which subject I shall touch upon later.

The Metropolitan Life Ins. Co.'s printing building on Long Island by Mr. Waid is an excellent example of reinforced concrete work. There is much restraint and a good use of the material.

The Marlborough-Blenheim in Atlantic City is one of the earliest of important reinforced structures in this country and though its enclosing walls are of hollow tile stuccoed, the exterior design is characteristically concrete. It was indeed a courageous undertaking. Architecturally, this building ranks high. There is a playfulness and picturesqueness which are well suited for a resort of the kind. Then there is much originality in the design without being outré. Price & McLannehan were its architects.

The Hide & Leather Building by Thomspon & Binger is a skyscraper built of reinforced concrete. Just what are the practical limitations as to height of reinforced concrete buildings is a matter of opinion. The sizes required for columns are usually the determining factor. Our own experience would indicate that for buildings of 10, even 12 floors, to carry ordinary live loads, the columns need be no larger than of structural steel fireproofed. Beyond that height, we prefer to use the latter. The building under consideration is a sincere and reasonably successful effort at producing an attractive building in reinforced concrete. It would have been better in my opinion, were its details of better character and had some of the applied ornamentation been omitted. Its straightforward treatment of piers, its base and topping out are to be commended.

Considerable excellent concrete work has been done around Dayton. The Beaver Power Co. building is an example. Entirely done in concrete, it is of interest in its simple variation of pier sizes, cornice and surface treatment. It is a very satisfactory structure architecturally, and so is the building for the American Tool Works Co. in Cincinnati, by Stegner & Hughes, handled in a manner not unlike the Beaver building.

Reinforced concrete is at its best when used for low buildings as in Porto Rico and other Southern places. The Presbyterian Hospital at San Juan indicates how beautifully the material lends itself to such structures. This is concrete design at its best. Simple pier and wall surfaces, square and semi-circular openings, no cornice and plain belt courses. Of similar character though a high building is the new University Club in Los Angeles by Allison & Allison. This, I believe, one of the best buildings we have in concrete. Its design is excellent in every detail and particularly noteworthy is the surface treatment which apparently exposed form marks without hesitancy.

An excellent example of good concrete design is the Harrison Garage, San Francisco, by McDonald & Applegarth. Apparently the surface is stuccoed but there is beauty in its simplicity and well proportioned mass.

The Bureau of Printing & Engraving at Washington is a monumental structure with its main facades of stone. It is questionable, however, whether they are better architecture than the inner courts which are of reinforced concrete. Certainly the latter serve the building better in a practical way. They are of exemplary design.

A building recently completed in Brooklyn for Kahn & Feldman by Buchanan & Kahn has splendid character. It is the industrial building glorified.

As to residence work, it has been the general impression that houses built of reinforced concrete are more costly than such of brick or tile. Many results, however, especially the work of Hueber Bros., of Syracuse, which is particularly notable, would prove the contrary. Furthermore a number of systems of precast sections are coming into vogue which should make reinforced concrete used in that manner very desirable.

Two very excellent examples are the facades of the Tilling Stevens Motor Co. at Maidstone and the Napier Motor Co. at Acton. It is to be regretted that the surface is lined off to represent stones, the more so since the designs otherwise seem so appropriate for concrete. The ornaments were precast and set into forms before pouring of the concrete.

Since my own office has done a great deal of industrial work in reinforced concrete to which we have tried to give an architectural note, I trust that my referring to it will not be taken amiss. The automobile industry which to our good fortune established itself in Detroit some 20 years ago required large areas of manufacturing space with a maximum amount of light, rigid floors to carry fast moving machinery and buildings necessarily fireproof. Here was an excellent opportunity for reinforced concrete. The Packard Motor Car Co. was among the first to adopt the construction. The Packard company's main building faces Detroit's principal boulevard.

Our first problem affording, because of its imposing dimensions, a real opportunity, was the first unit of the Ford Motor plant at Highland Park. The building is some 800 ft. long and 4 stories high. We here used brick work as trimming, facing the piers of the entire lower floor therewith, also the corner and intermediate pylons. Between the latter we have above the lower floor the regular system of columns and lintels with a simple concrete cornice crowning the structure. In this building were used probably the first steel sash, now so generally employed, at least sash of standard factory type. They were shipped direct from England. We have felt, and my colleagures have been kind enough to concur in this, that this building marked a step in advance in factory building, in that it attempted to make the building an architectural composition without sacrifice of any practical essential. Among other commissions entrusted to us are the plants of Hudson Motor Car Co., also that of the Continental and the Lozier companies. The two former adjoin each other and face an important thoroughfare. In all of these buildings we have adhered to a combination of exposed concrete, some of it structural, with brick and cement colored tile inserts, with results that have won favorable comment from layman and architect.

In the Continental Motor plant we indulged in more detail; to excess, we feel now, and were we to do it again we would omit much of it. The Lozier plant is simpler and I believe correspondingly more effective.

Among our more recent works are the Fort Shelby Garage and the Ford Motor Sales building in Detroit. In both of the latter we feel we have struck a somewhat new note.

Our most recent structure of importance is the new body plant for the Studebaker Corporation in South Bend. Here we had a rare opportunity, the building being six stories high and over 1000 ft. long. We have in this increased the more usual brick pylons to brick pavilions with exposed concrete mullions.

The Mishawaka Woolen Mills Co. building is a solution of a somewhat different problem. There is necessarily in all these buildings considerable similarity, for the fixed arrangement of interior columns and necessity for maximum glass area afford but little opportunity for decided difference in appearance.

In most of our work we have treated exterior concrete with carborundum and given it several coats of cement paint, which in contrast to the brickwork proves effective. This matter of surface treatment is still a problem. How will it be solved? Left in its natural state untouched from the forms, cement washed, or rubbed with carborundum, concrete at best is cold in color and uninteresting in texture. Stucco or other surface applications have proved on the whole a failure in most parts of the country, for they do not adhere because of difference in expansion and contraction and develop unsightly cracks. Attempts have been made to treat the surface by tooling or exposing the aggregate but few have proved successful and none economical in cost. A ray of hope is afforded by the remarkable work of John J. Early. His first efforts in connection with Meridian Park at Washington, D. C., gave promise; his latest, however is a distinct achievement. By the use of aggregates carefully selected as to color and size and these exposed through wire brushing and washing with acid, he produces a surface and texture of surpassing beauty. Withal, it is no imitation of anything but true concrete, remarkable in its effectiveness Mr. Early claims that a surface application by this process will positively adhere. If so, I know of nothing that will be more welcome with designers in reinforced concrete. Mr. Early has done remarkable work and deserves the acclaim of all interested in the subject. It is to be hoped that he will continue his good work.

The Future of Concrete

Now what of the future for reinforced concrete? I am convinced that we have only made a fair start and that its development both structural and artistic will exceed any present expectation. Furthermore I believe that concrete in its most direct form will grow in use for exterior facings. Gradually we shall accustom ourselves to form marks; we shall not only accept them but take advantage thereof; we shall eliminate cement washing and rubbing even pointing and gain an artistic effect through the play of light and shade and emphasis of the monolithic mass which it really is. Furthermore we shall accustom ourselves to weather stains and make a virtue thereof, just as the grime of London only adds interest to its architecture. We shall pay more attention to design in mass, to interesting outlines and less to minor details. The way has been shown in a number of existing works. Others will carry on and continue to develop the new material, further proving that reinforced concrete is the most notable contribution to the art of building since the structural steel frame came into existence.

The Portland Cement Association announces the opening of a district office in the First National Bank Building, Oklahoma City, Okla., effective March 1, with B. E. Clark as district engineer. The Oklahoma City office will be in responsible charge of Portland Cement Association work in Oklahoma.

Mr. Clark joined the staff of the Association November 1922, since which time he has been association field engineer in Oklahoma.

Heavy Test Loads on Hollow Cinder Block Floor Slabs Cause Slight Permanent Deflection

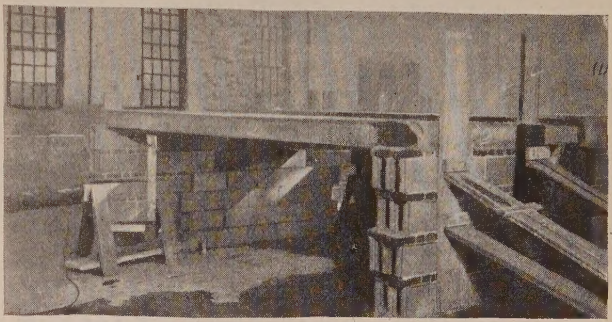
Tests conducted on three hollow cinder block floors constructed in a manner similar to what is spoken of as hollow tile construction, with hollow cinder block occupying the same position that the terra-cotta tile does, resulted in slight permanent deflection in the slabs under loadings much in excess of the computed allowable live loads. The tests illustrated in the accompanying figures were made by J. R. Shank, professor of civil engineering, Ohio State University, on test floors poured December 15, 1923, inside of one of the buildings of the Indianapolis Switch & Frog Co., at Springfield, Ohio. The tests were made to determine the strength of slabs constructed according to the McIlroy fireproof floor system, invented by William McIlroy, Springfield, O.

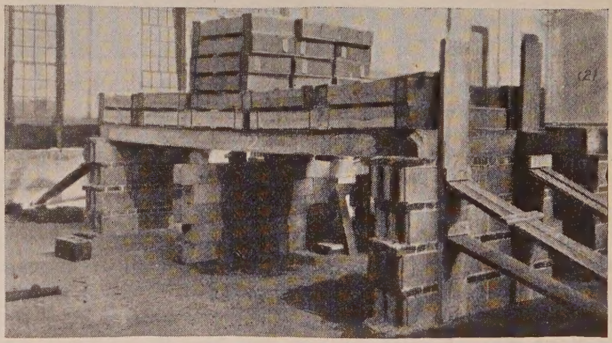
A few advantages of the hollow cinder block floors are cited by Mr. McIlroy as follows: Minimum simple forms; if forms are level, no other leveling is necessary, as the blocks are all true to size and shape and do not warp; sleepers can be nailed into the blocks with ordinary nails before the beams are poured; no cinder fill required; less plaster on ceiling and no lath; fixtures, shafting or suspended ceiling can be fastened to the underside with ordinary nails, screws or lags and they will hold; from 24 to 40 lb. dead weight per sq. ft. can be eliminated, and more live load carried at less cost than any other fireproof floor; it is a better fire and water resistant, sound deadener and insulator, and has splendid acoustic qualities, as proved in buildings erected by the inventor.

In the case of the test floors, the cinder blocks were placed with their ends supported on planks which formed the bottom forms for the reinforced concrete beams. The ends of the cinder blocks acted as the side forms for the reinforced concrete beams. Fig. 1 shows the test floor No. II ready for the test load. Fig. 4 shows the under side of this test floor after it had been tested. Fig. 4 also shows a sectional diagram illustrating the arrangement of the cinder blocks with respect to the concrete beams.

The concrete work on these tests slabs was done in the usual manner employed in building construction. No extra effort was exerted to have a laboratory concrete or even a good grade of construction concrete. A slump test, according to the methods suggested by the American Society for Testing Materials and the material going into test floor No. III, gave a slump of 8 in., indicating a wet consistency. Concrete in test floor No. II had a slump of 5½ in.

The proportions used were 1:2:4; the sand used being a local sand, well graded but somewhat dirty, and the gravel being graded rather fine, much of it ranging between ¼ in. and ½ in., with considerable sand between ⅛ in. and ¼ in. The maximum size was ¾ in. A standard brand of cement was used, and the steel reinforcing was of mild billet steel such as ordinarily used for reinforcing concrete.





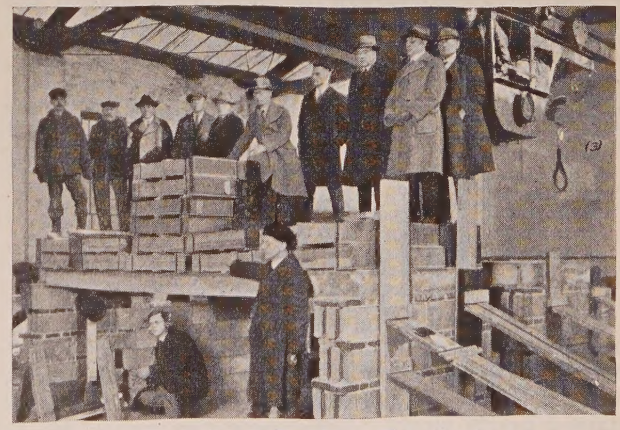
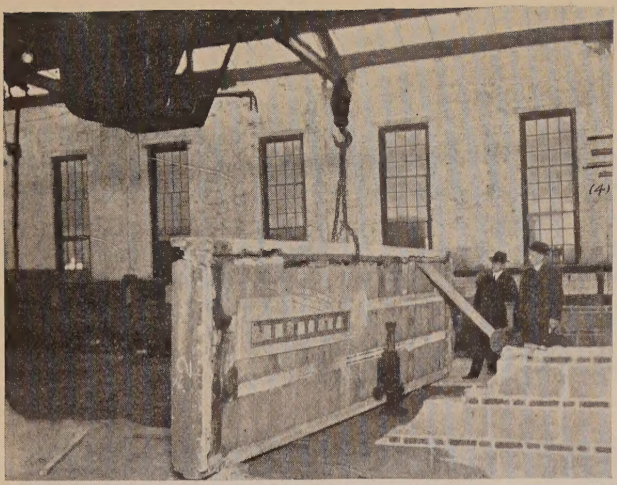


Fig. 1—Test Floor No. II Ready for Test Load

Figs. 2 and 3—Floor No. II Under Test

A test cylinder, 6 in. in diameter by 12 in., was made from the concrete going into each floor. These cylinders were made in steel forms and were stored with the test floors from the time of pouring until the date immediately preceding the breaking. At the time of making the test floors, two blocks of concrete were poured from the material in test floor No. II, using one of the cinder block as forms. These two block were broken on the same date as the test cylinders poured in the steel forms, the object being to see if cinder block had any effect on the strength of the adjoining concrete. All test cylinders were broken at Brown Hall, Ohio



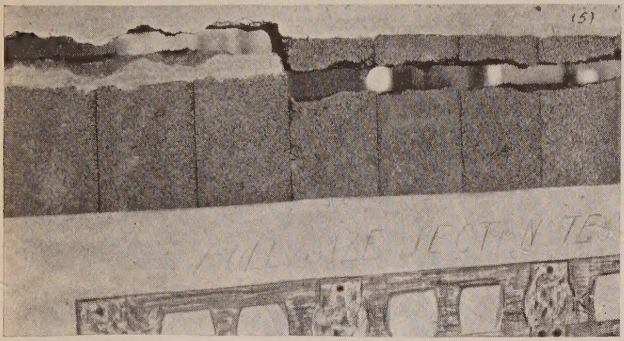


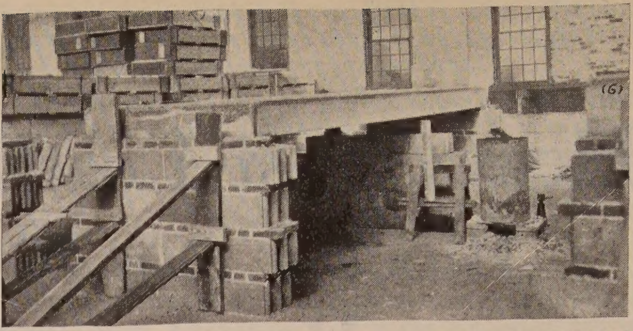
FIG. 4—THE SAME TEST FLOOR WITH SECTIONAL DIAGRAM SHOWING ARRANGEMENT OF THE BLOCK AND CONCRETE BEAMS

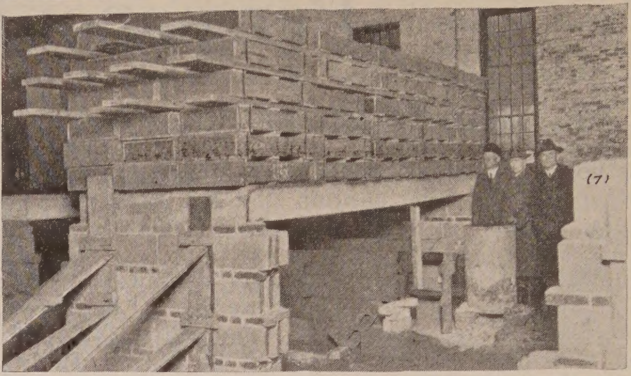
FIG. 5—THE BREAK IN THE BLOCK WHICH RESULTED FROM BOND BETWEEN THE CONCRETE AND THE CINDER BLOCK

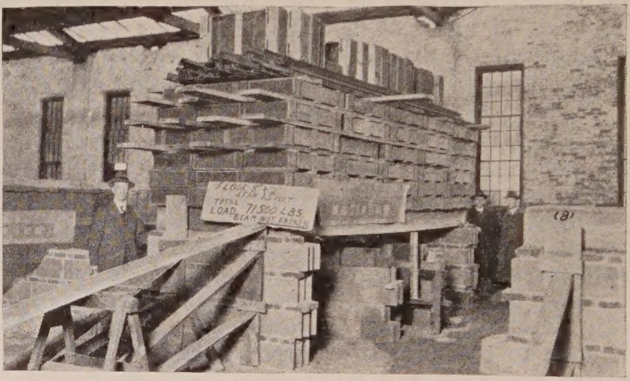
State University, and showed rather wide variation, although the appearance of the concrete as it went into the forms did not change much. The concrete was made dryer as the work progressed. The variation in water content, as evidenced by the slump of 8 in. for floor No. III and 5½ in. for No. II, showed up in the test results in the accompanying table.

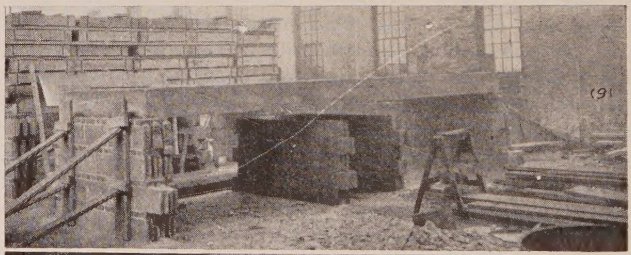
6 in. Dia. x 12 in. cylinders	Test Load lbs.	Unit Strength lb. per sq. in
From test floor No. I	71,600	2,530
From test floor No. II	47,400	1,675
From test floor No. III	36,300	1,282
		1,829 Av.
Concrete from test floor		
No. II, Molded in cinder block	36,580	2,205
Cross-section 16.57 sq. in	38,100	2,300
		2,252 Av.
Concrete Block		
126.5 sq. in. gross	121,150	960
91.8 sq. in. net	121,150	1,320

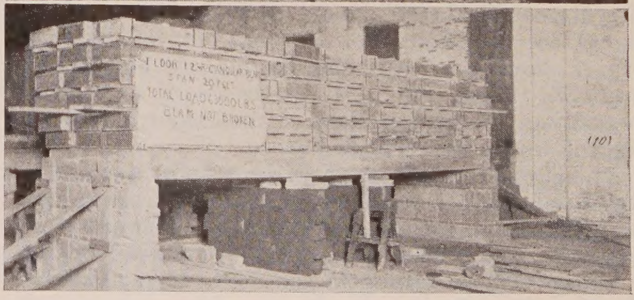
It is stated in the report that the increase in the strength of concrete poured into the cinder block mold over that of the same batch poured into the steel mold probably explains some of the high strength attained by the floors. Apparently the cinder block took up considerable of the excess water. It was noted during the pouring that there was no water drip under the floor, the cinder block absorbing all the excess water. In removing the cinder block mold from the test pieces molded in them, the toughness of the cinder block was noted. A cold chisel could be driven into the cinder concrete an inch or more before the wedge action would split off a portion. This bond to the cinder concrete is more clearly shown in Figs. 4 and 5. When removing the test floor No. II after it had been loaded, a hole was made through one of the cinder blocks through which a chain was passed. The test floor was lifted bodily and carried 2 or 3 ft. when the break formed, as shown in Fig. 5.











FIGS. 6, 7 AND 8—TEST FLOOR NO. I

FIGS. 9 AND 10—TEST FLOOR NO. III. FIG. 10 SHOWS THE BEAM UNBROKEN UNDER LOAD OF 63,000 LB.

The test floors and compression specimens were allowed to set and harden a longer time than 28 days on account of the coldness of the weather. The test floors were covered over with planks and shavings during the setting period, but there was no artificial heat applied. The salamanders were placed only the night before tests were conducted to make it more

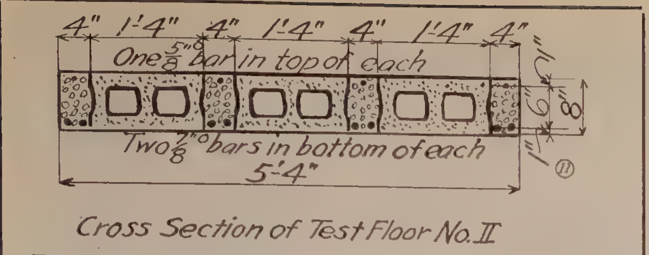

4" 1'-4" 4" 1'-4" 4" 1'-4" 4"
One 5/8" bar in top of each
6"
8"
Two 5/8" bars in bottom of each
1"
5'-4"
⑪
Cross Section of Test Floor No. II

FIG. 11—CROSS SECTION OF TEST FLOOR NO. II

comfortable for the spectators. The temperature at times registered below zero.

TEST FLOOR NO. II

Test floor No. II was made up of four rectangular beams with cinder blocks between. Details of construction are shown in Fig. 11. The material used for the loading was welding iron crated for shipment in crates whose total weight was 525 lb. The crates were laid as shown in Fig. 3. Deflections were measured from a hook driven into the under part of the cinder block at the middle of the span to a brass wire tightly stretched from a support off one side of the test floor to another on the other side just under the hook. The wall under the test floor near the center was placed as a protection feature, not being in contact with the test floor at any time.

The clear span between supports was 15 ft. The end supporting walls were 13 in. thick and the loading was placed out nearly to the backs of the supporting walls.

The load actually placed on the test floor amounted to 19,950 lb. with the 8 men added at 160 lb. each, the total load would be 21,230 lb. Reduced to an equivalent uniform load based on the bending moments at the center, the loading would be, without including the men, 1,657 lb. per lin. ft. which would be 311 lb. per sq. ft. The total load per lin. ft., including the dead load was 370 lb. per sq. ft. producing a bending moment of 57,100 lb. ft. which is 360% of the computed working resisting moment, using n as 15 in the straight line formula and considering the top steel in compression. The excellent bond between the cinder blocks and the concrete, evidently caused the blocks to furnish added strength to the concrete beams in resisting the bending.

The maximum deflection under various degrees of loading was 0.856 in. A deflection of 1 in 360 occurred at an equivalent uniform loading of 1,045 lb. per lin. ft. or 196 lb. per sq. ft. which is 350% in excess of the computed allowable live load. After the live load had all been taken off, a permanent deflection of about 1/10 of an inch remained.

TESTS OF FLOOR NO. I

Floor No. I shown in Figs. 6, 7, and 8 and in detail in Fig. 12 was of the T-beam style of construction with wood sleepers placed above the middle of each row of cinder block which would be used in construction to carry the floor. The same kind of cinder block were used as in test floor No. II, making the test floor 8 in. x 2 in. with a width of Tee of 13¾ in. and a thickness of 2 in. The material used for loading was, in general, the same as in test floor No. II. The deflections were measured in the same manner as for test floor No. II and two protection walls were placed under the slab as it was intended to break this floor. It was not possible to load this floor to destruction as the crane would not lift any higher than the top row of crates shown in Fig. 8.

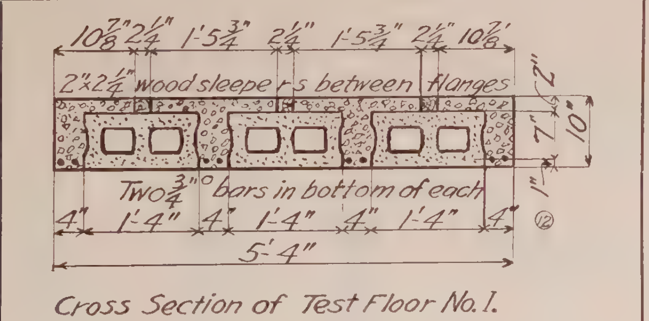

10 7/8" 2 1/4" 1'-5 3/4" 2 1/4" 1'-5 3/4" 2 1/4" 10 7/8"
2"x2 1/4" wood sleepers between flanges
2"
7"
10"
Two 3/4" bars in bottom of each
1"
4" 1'-4" 4" 1'-4" 4" 1'-4" 4"
5'-4"
⑫
Cross Section of Test Floor No. I.

FIG. 12—CROSS SECTION OF TEST FLOOR NO. I

The spans used were 15 ft. 8 in., being the distance from center to center of end concrete pieces. The end supporting walls appeared to stay with the test floor during its deflection. The load that was actually placed on the test floor after making all proper deduction was 60,000 lb. The uniform load per lin. ft. on this basis would be 3,830 ft. lb. or load per sq. ft. of 719 lb. This is 495% of the computed allowable live load. If the dead load bending moment be added to that of the actually loaded live load, the result would be a total of 130,850 ft. lb. or 354% of the resisting moment computed on the basis of 700 lb. per sq. in. on the concrete.

The maximum fibre stress on the concrete would be approximately, 1,950 lb. per sq. in., computed according to parabolic variation. The stress shown in the test cylinder made from the same material as this test floor was 2,530 lb. per sq. in. and the average of the three was 1,829. This test floor was designed without any excess steel in the bottom. The fibre stress in this steel, as is usually computed, would run over 50,000 per sq. in. This seems to indicate a rather unusual assistance being given to the tension steel. The cracks which formed under the heavy loading were always at the joints between the cinder block, which tends to show that the cinder block did assist at least between these joints.

The total deflection for this test floor was 0.900 in. It was impossible to finish loading the test floor on the date started, on account of lack of time. The load which showed a deflection of 0.5 in. was allowed to stand for the entire week and the remainder of the loading was done one week later. The total deflection on Feb. 2, the later date, was 0.628 in., showing a settlement of 0.218 in. due to flow in the concrete. When all of the live load was removed the beam came back ⅝ in. This made a permanent set of .275 in. with the flow. If the flow be deducted the comeback would be .147 or a little over ⅛ in.

TEST FLOOR NO. III

Test floor No. III is shown in Figs. 9 and 10 and in detail in Fig. 13. The depth of the beam is 12 in., the width of each rectangular beam 5 in. and the clear span 20 ft., the width of each block being 16 in. The block contained some sand as is demanded at Detroit where the block were made. These block were brought in from the outside because 12-in. cinder block were not available locally at the time. There were also ¼-in. round continuous stirrups used with verticals spaced 6½ in. from the end of the clear span, then 14 in., then 15 in. at each end and in all rectangular beams. The working span was taken as 20 ft. 8 in.

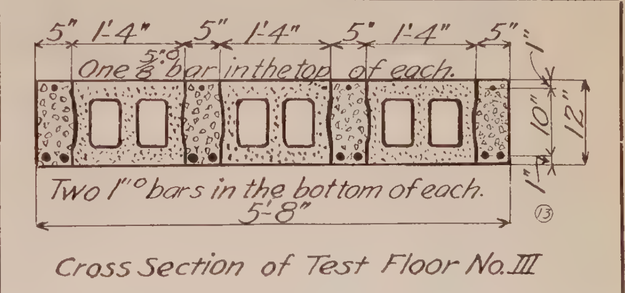

5" 1'-4" 5" 1'-4" 5" 1'-4" 5"
One 5/8" bar in the top of each.
10"
12"
1"
Two 1" bars in the bottom of each.
5'-8"
⑬
Cross Section of Test Floor No. III

FIG. 13—CROSS SECTION OF TEST FLOOR NO. III

The load that was actually placed on the test floor, both dead and live load, was 3,276 lb. per lin. ft. causing a maximum fibre stress in the concrete of 2,245 lb. per sq. in., computed by the parabolic method of 2990 lb. per sq. in. computed by the straight line method. This is 427% of the allowable load at 600 lb. per sq. in. The test cylinder in this case gave a unit stress of only 1,282 lb. per sq. in. The total deflection for this test floor was 1.208 in.

Replacing Cuts Through Concrete Pavements

When cuts are made through concrete pavements to permit repair or installation of underground structures, the patch can be made so that it can hardly be distinguished if proper precautions are taken with the work.

Good practice includes trimming the edges of the old pavement and cutting a vertical square edge 1 in. deep. The subgrade must be tamped thoroughly to avoid any further settlement which would cause it to separate from the slab. New concrete should be mixed on the pavement near the hole just before it is placed, care being exercised that a rather stiff mixture be used. The edges of the old concrete should be thoroughly wet before filling in with the new mix, but no water should be allowed to stand on the subgrade. Thorough tamping of the newly placed concrete is necessary. This should be repeated three times at intervals of about 10 minutes. After finishing the new concrete with a wooden float, it must be allowed to cure thoroughly before opening to traffic.

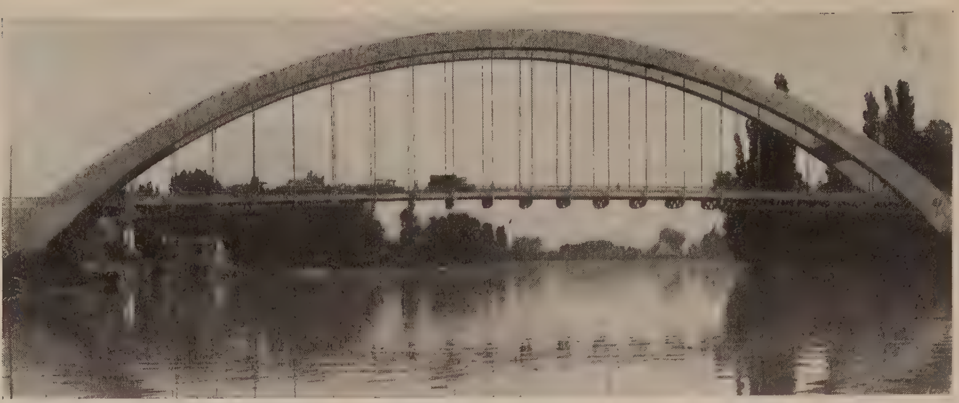


Fig. 7—The Finished Bridge over the Seine Showing Deck Suspended from Reinforced Concrete Arches

Longest Concrete Bridge Span Includes Deck Suspended From Arch Ribs

By Henry J. Harms
Rotterdam, Netherlands

The largest concrete bridge in the world—a title for a long time held by the so-called Risorgimento Bridge over the Tiber, in Rome, Italy—is now in France, at Saint-Pierre-du-Vauvray, over the Seine, in the Eure Department. Its span is 131.80 m., and the rise of the arch 25 m. The bridge consists of two fixed arches, 8.90 m. center to center. Each arch is made up of a hollow, square, concrete structure, 2.50 m. wide, and of a height varying from 4.10 m. at the base to 2.50 m. at the top. The thickness of the walls of the hollow arch varies at the bottom from 0.60 at the spring end of the arch to 0.33 m. at the top (although over the greater part of the arch this thickness is between 0.36 m. and 0.33 m., and the heavier section is only at the approach of the spring). The vertical walls are 0.20 m. thick for the greater portion, only increased in thickness to 0.30 m. near the base.

Below the bridge deck, the arches are solid; above the deck, the two arches are connected only by a concrete caisson-spacer, of hollow section also, about 5 m. above the deck. (See Fig. 3.) The standing sides of these "spacers" are perpendicular to the arch, the two other sides, top and bottom, are therefore unequal, the lower one being 4 m. and the top one 5 m. long. The spacer walls are very thin, only 8 cm., except from the bottom which is 10 cm. The spacer is reinforced in the middle by a web, 50 cm. high and 10 cm. thick.

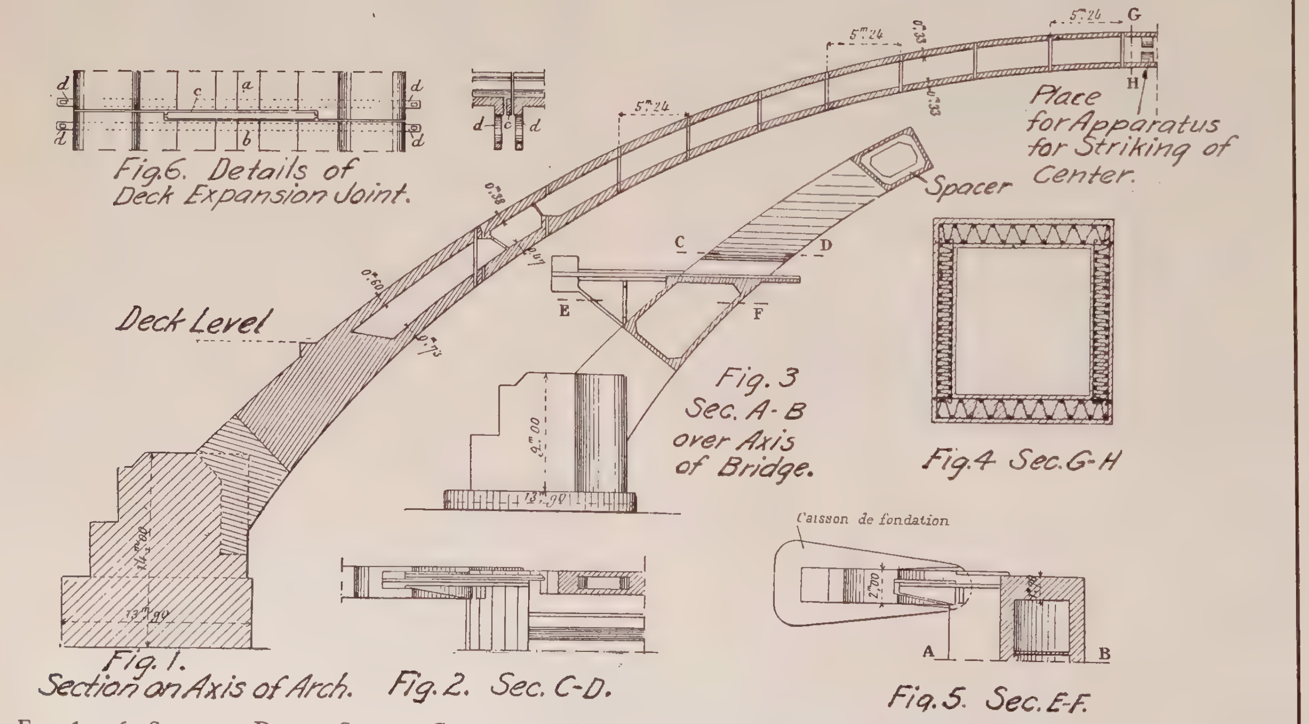


Fig. 6. Details of Deck Expansion Joint.

Fig. 1. Section on Axis of Arch.

Fig. 2. Sec. C-D.

Fig. 3 Sec. A-B over Axis of Bridge.

Fig. 4 Sec. G-H

Fig. 5. Sec. E-F.

Figs. 1 to 6—Sectional Details Showing Construction Details Saint-Pierre-du-Vauvray Bridge. Courtesy *Le Genie Civil*

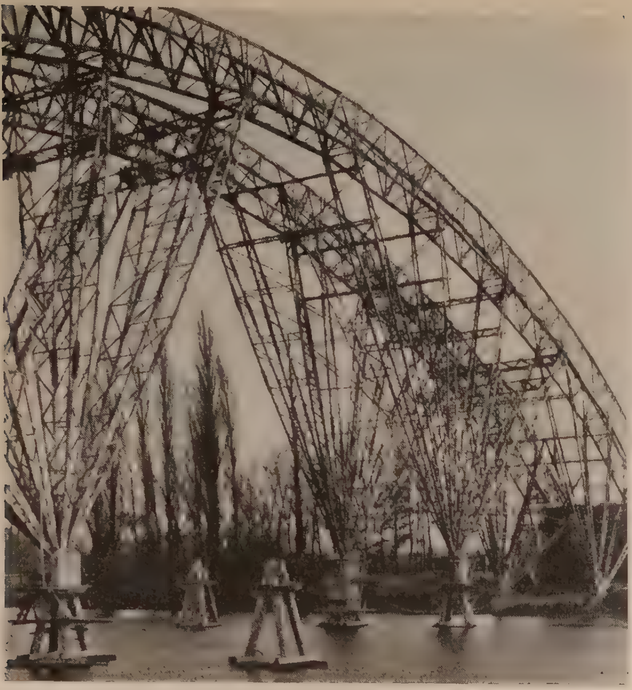


FIG. 8—VIEW DURING ERECTION OF THE CENTERING

Below the deck the two arches are connected by a large caisson (Fig. 3), the top wall being horizontal, and just below the roadway and the lower wall, perpendicular to the arch; the maximum height is therefore along the intrados and is about 8 m. The arches proper really start above the deck, as the lower part can be considered as an extension of the abutments.

Each arch abuts on a concrete caisson (Figs. 3 and 5), the horizontal section of which is a triangle with rounded angles; the length of the caisson is 14 m., its width about 5.50 m. These abutments are built on a concrete caisson foundation, resting on a clay strata, about 13 m. below low-water and having traversed a thick layer of clay, under which is a layer of gravel and sand.

The bridge deck has a total width of 8.80 m. and of 8 m. between uprights. The highway is 5.35 m. wide, with two sidewalks of 1. 345 m. each. The deck is supported by concrete latticed beams, spaced 5.24 m. apart, which are hung from the arches by means of concrete-covered steel bars. Each hanger consists of 40 steel bars of 19 mm. diameter, ordinary reinforcing steel, covered with a strong cement mortar, and thus forming a reinforced concrete hanger of 0.14 x 0.14 m. section. These hangers are calculated so that the steel bars take up all tension, the concrete acting only as a better protection than paint.

Where the hangers traverse the arches, these have a vertical partition which serves to strengthen the structure and to furnish a means to fasten the hangers. To accomplish this last purpose, this partition has in the lower part a triangular opening, the point of which is directed downward and corresponds to a hole in the bottom panel of the arch. The steel bars of the hanger penetrate the vertical partition, and are then spread in the same manner as the strands of a hoisting cable in the ball above the hook; the ends of the bars are hooked, and once in place, the whole is surrounded by a strong cement mortar, which makes it monolithic with the rest of the partition. This partition is heavily reinforced by bars, especially in the lower portion, which are bent upward at each side of the hanger and hook into the sides of the arch and the upper part of the partition. Thus the whole structure supports that part of the deck at that point. The vertical partitions have a manhole in the top to permit circulating inside the arches.

The hanger bars are spread and hooked at their lower end in the form of stirrups or hoops, and intermingle with the reinforcing of the ends of the supporting beams, which had openings there for this purpose that were afterwards filled with very strong cement mortar.

The transverse beams are formed, as stated, as latticed beams, of a maximum height of 1.50 m. and a width of 0.20 m. They are precast on the job.

CONSTRUCTION METHODS

Requirements were that navigation be hindred as little as possible, and that only a small number of points of supports be established in the river bed. Only two rows of pile-clusters were used in the river bed, and one other row near the left bank; while on the right bank the foundation of the former abutment of the dismantled steel bridge was used as a support. Each row consisted of 4 pile-clusters of 4 piles each, the two middle clusters serving as supports for the center, the two outer ones for protection. The center was carried by a series of timber masts, likened by the contractors to sheers, of triangular spindle shape, and constructed of boards fastened together by ordinary nails. In fact, for the construction of the center, as well as for the molds, scaffolding, etc., the contractors disregarded the usual method of assembly by bolts; they used boards, the number of which varied with the stresses and which were nailed together, the number of nails being determined by calculation. This system, used by these contractors before on other center work, has enabled them, as they claim, to obtain a rigidity not obtainable with bolt assembly. They hold that the bolt holes, always becoming oblong in use, and the tightness of the joints between the pieces varying with the shrinkage and swelling of the wood, the whole timber assembly is often subject to important deformations.

The above-named sheers, assembled on shore, were put in place by means of an aerial cableway, of 170-m. span, installed across the stream, with a double main cable, and supported by two masts on the banks. The cigar-shaped masts were constructed on the same principle as the timber masts of nailed boards; they were jointed at the base and held in position by means of guy ropes. Each one of the supporting clusters in the river carried four sheers and those near the banks three, the outer one of the last meeting the inner one of those in the river, and twelve points of supports being thus formed—spaced almost equally along the intrados of the centering. This latter consisted of a latticed arch, formed also of nailed boards. The molds for the arches were made of elementary panels, prepared on shore and placed by the cableway.

Concrete was machine-mixed on shore and transported by the cableway in dump buckets. Concreting was done in four distinct sections. In this manner the center was progressively loaded, and excessive unsymmetric local overloads, that would have been caused by pouring the whole section at once, were avoided.

The reinforcement of the arches is relatively light, and consists of round bars of small diameter, uniformly distributed, in the sidewalls, as well as in top and bottom panels. The total area of the metal varies in different parts of the arches; near the key-piece, for instance, the reinforcement consists of 10 bars of 14 mm. and 10 of 7 mm. for top and bottom panel, and 11 bars of 7 mm. for each one of the lateral walls.

The concrete was proportioned 350 kilos cement per

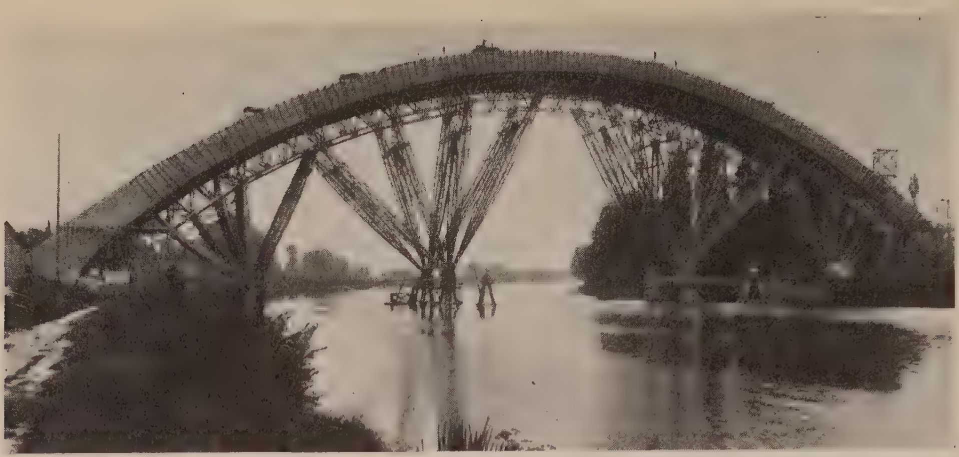


Fig 10—Concreting of the Arches

cu. m. mixed concrete, and was poured quite wet, in order to allow easy placing in the molds. To assure perfect filling of the molds and homogenity of the concrete, compressed air vibrators were used, similar to drilling or riveting hammers, that communicated a slight vibratory movement to the mold, thereby facilitating the settling of the concrete.

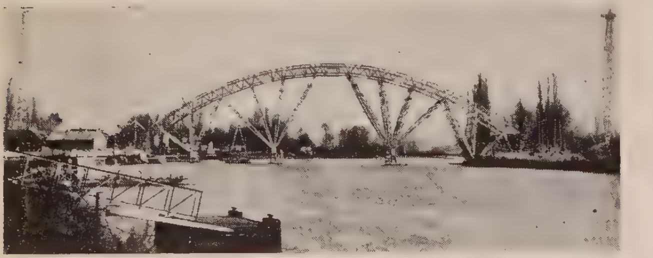


Fig. 9—Erection of Center Nearly Finished

The striking of the center was done in a special manner, as originated by M. Freyssinet and applied before on the bridge of Villeneuve-sur-Lot. This original and daring process consists in lifting the arch off the center, instead of lowering the latter under the arch. For this purpose, each arch is first built in the form of two independent semi-arches, separated by a small keying space. In this space are placed hydraulic jacks, acting horizontally and strong enough to create an effort capable of overcoming the pressure of the arches that would arise with an ordinary striking of the center. Working the jacks, the two semi-arches were spread apart, and lifted at the same time, from the center. Between the jacks, heavily reinforced concrete blocks, strongly proportioned, were then placed, after being freshly coated with cement, on which the joint was allowed to close, by letting the water run off freely from the jacks.

After striking the center, the caisson-spacers above alluded to were built and the deck assembled. The last one consists of reinforced concrete slabs, resting on the transverse beams already spoken of. In order to provide for expansion of the deck, an expansion joint has been left at each of its extremities (Fig. 6). This joint is formed by a complete cut of the deck. Each one of the two sides of the cuts rests on a transverse beam, two beams instead of one being hung side by side at that point (see photo 4). The two extremities *a* and *b* of the deck (Fig. 6), facing each other, have an offset forming a rectangular empty space of about 20 cm. wide; which space is almost filled by a small reinforced concrete beam, fixed at its ends to the two parts of the deck by means of semi-articulations. The two parts of the deck are thus connected by some sort of an elastic joint, and the opening is simply covered by a T-iron.

The tests of the bridge consisted of two essays, one under dead and one under rolling load. With a uniform load of 400 kilos. per sq. m., maximum deflection was 12 mm. for the arch and 14 mm. for the deck.

The tests for rolling load consisted of the simultaneous passage of an up-going row of vehicles—composed of two 7-ton trucks, drawing a 4-wheel trailer of 7 and 12 tons—and a down-going row—composed of two 5-ton trucks, followed by a 16-ton steam roller and an 8-ton truck, the sidewalks being loaded at the same time by a uniform load of 400 kilos. per sq. m. Under this total load, the maximum deflection was only 2 mm. for the arch and 7 mm. for the deck.

Contractors were Messrs. Limousine & Co., of Paris, the design is of M. Freyssinet.

Wall Plaster

Wall plaster — its ingredients, preparation and properties—is treated in Circular No. 151, which has been issued by the United States Bureau of Standards as a report of the Bureau of Standards Plastering Conference. The following is abstracted from a report dated January 9, 1924.

The art of plastering is intimately connected with the comfort and safety of the occupancy of the building, yet few outside the trade understand the nature of the material and the details of the work required to produce the required results. The recently aroused interest in building has carried with it interest in plastering.

Much information about the factors which enter into successful plastering was found available in the trade. Circular No. 151 represents an attempt to collect and correlate this information for the public benefit.

To assist in the work, a committee known as the Bureau of Standards Plastering Conference was organized of men most familiar with different phases of the subject. From the information thus furnished and laboratory research work, the committee has been able in many cases to explain not only how an operation is conducted but also why this is the best way of doing it. It is recommended that furring be used when plastering exterior masonry walls to prevent damage due to condensed moisture.

When masonry walls are to be plastered without furring, the surface of the masonry should be true and clean and of proper degree of wetness.

Specifications and directions for erecting are given for wood, wire and metal lath and gypsum plaster board.

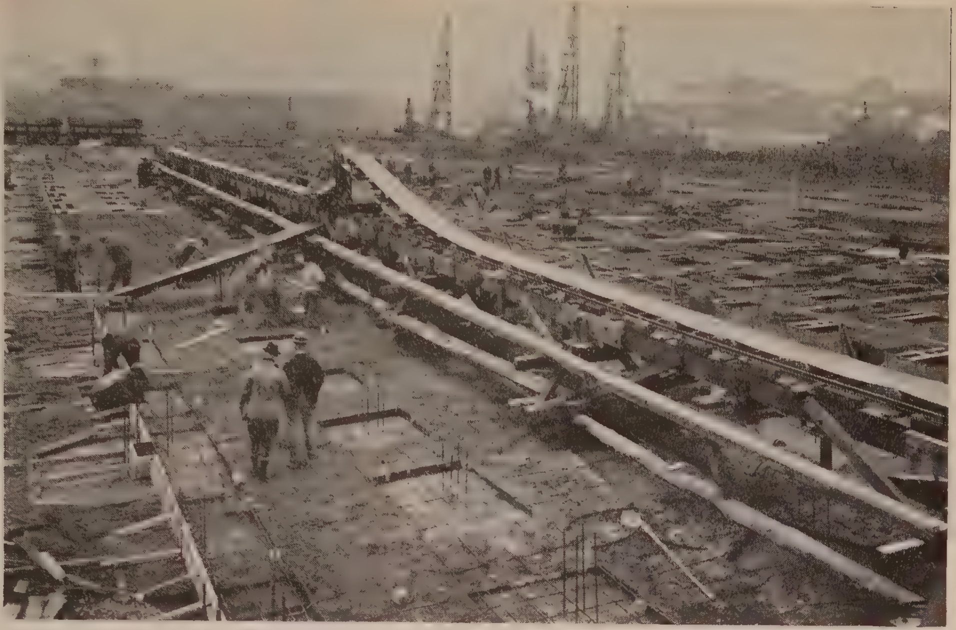
Descriptions and specifications are given for the ingredients of plaster—lime, gypsum, cement, sand, air, water, etc.

The chief properties of the wet mix are discussed as they affect the quality of the finished plaster.

Complete directions are given for the mixing of the ingredients and the application of the wet mix to the wall.

The chief properties of the hardened plaster are discussed as they affect the comfort and safety of the occupants. Different kinds of decorative features are described. Some of the common defects are described and the causes and remedies suggested.

FIG. 1 — TRANSVERSE DISTRIBUTING BELT FOR HANDLING FRESHLY MIXED CONCRETE WITH MOVABLE CHUTE IN PLACE. PLACING REINFORCING STEEL, KEARNY, N. J., PLANT OF WESTERN ELECTRIC CO.



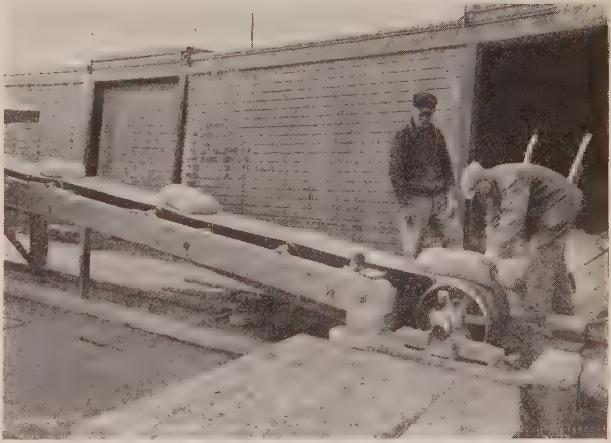
Long Conveyor Belts Distribute Concrete on Job

An unusual and ingenious system was installed for transporting freshly mixed concrete from the mixing plant into place in the work of transforming the 60-acre tract of marshy swamp into the new plant for the Western Electric Co., at Kearny, N. J. The method for solving the problem of conveying concrete economically over the widely spread area in the foundation of the cable building of this plant by the aid of belt conveyors is described in the *Contractors' Atlas*, published by the Atlas Portland Cement Co.

As the contractor on this job, Henry Steers, Inc., New York City, is equipped with barges, floating mixing plant, and similar floating equipment used in specializing in harbor and dock work, it was decided that the most convenient and economical layout was to keep the floating mixing plant in one location, bringing the aggregate and cement to the mixer by barge.

As shown in Fig. 4, the mixing plant was equipped with a short concreting tower, by which the freshly mixed concrete was elevated from the mixer and dumped into two short, sectional chutes discharging into a small feeding hopper which distributed the concrete onto the main conveyor belt. The length of the east and west conveyor onto which the concrete from the mixing plant was spouted was 600 ft. This conveyor belt was located about 12 or 15 ft. above ground level and supported as shown in the illustrations. At right angles to the main conveyor belt was another conveyor, approximately 200 ft. long, which was used as a distributing conveyor for distributing the concrete over the wide area. The 200-ft. transverse conveyor was so arranged that it could be moved on rollers, and could receive concrete from the main conveyor belt at any point and also distributed at any point by means of side chutes.

The concrete was conveyed from the main belt to the second belt by a mechanical arrangement, which



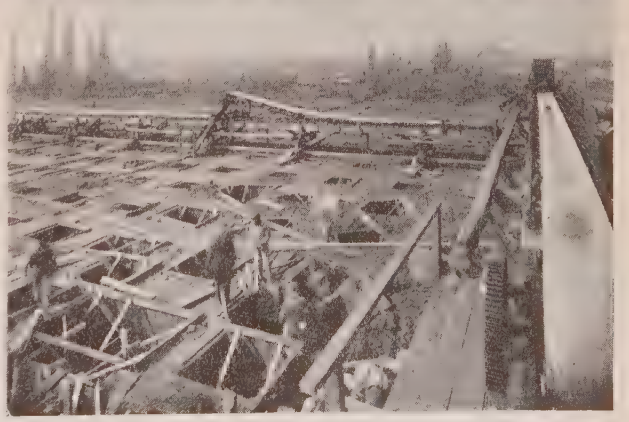


FIG. 2—BELT CONVEYOR TAKING ATLAS PORTLAND CEMENT IN BAGS FROM BARGE TO MIXING PLANT. OVER 50,000 BARRELS OF CEMENT USED IN THIS ENTIRE WORK

FIG. 3—MAIN CONVEYOR BELT, WITH TRANSVERSE DISTRIBUTING BELT NEAR TOP OF ILLUSTRATION. CONCRETE DISCHARGED TO DISTRIBUTING BELT BY MOVABLE CHUTE

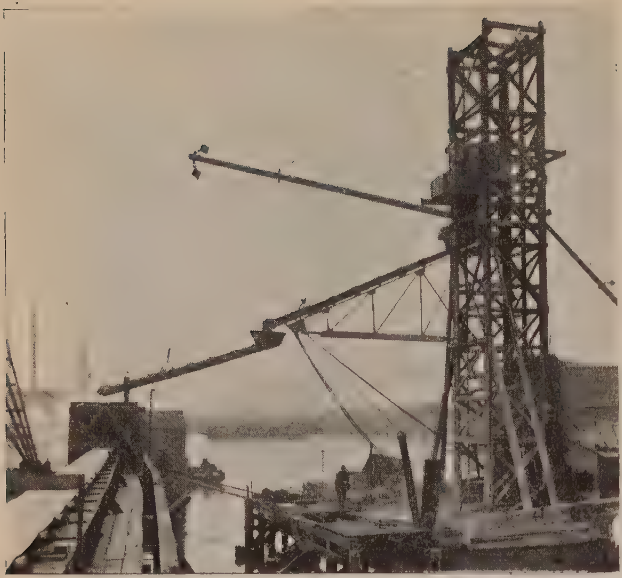
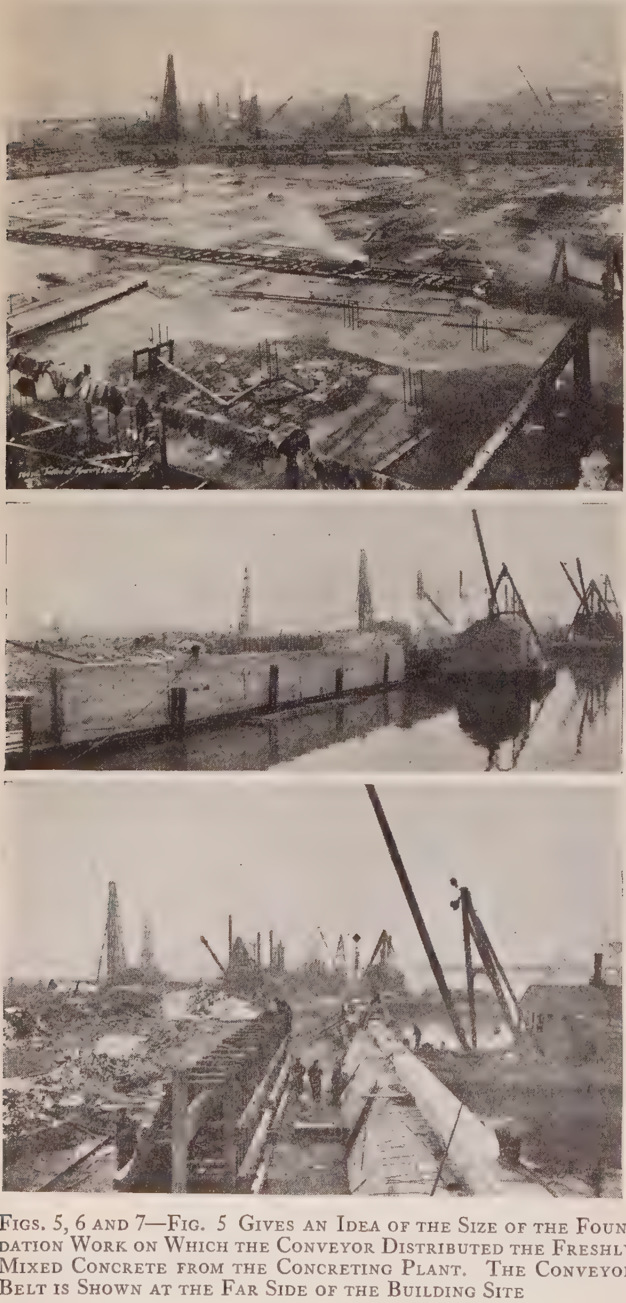
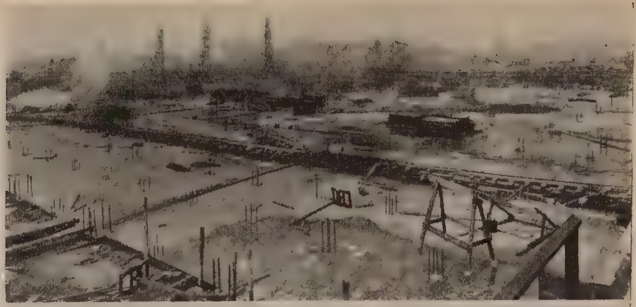


Fig. 4—Mixing Plant Located on Barge and Discharging to Belt Conveyor



Figs. 5, 6 and 7—Fig. 5 Gives an Idea of the Size of the Foundation Work on Which the Conveyor Distributed the Freshly Mixed Concrete from the Concreting Plant. The Conveyor Belt is Shown at the Far Side of the Building Site



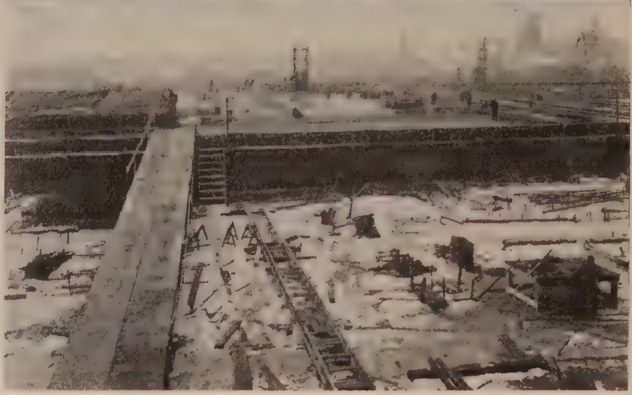


Fig. 8—Cable Building Floor as it Appeared Jan. 2, 1924

Fig. 9—First Floor of One of Cable Buildings on Feb. 15, 1924, with Conveyor in the Foreground

dumped the concrete into a chute and thence to the second belt. The width of the 6-ply Pioneer conveying belt was 24 in., and for the two conveyors a combined length of 1600 ft. of belting was required. It had a $\frac{1}{8}$-in. rubber surface on the carrying side, and a $\frac{1}{16}$-in. rubber surface on the other side. The conveyors were furnished by the Conveying Weigher Co., New York City.

For distributing concrete to points not covered by the distribution belt, a narrow-gage industrial track with side dump cars was installed, these cars being filled with concrete by chutes from the main conveyor belt.

All the aggregates and cement were handled mechanically, the aggregates by means of clam-shell buckets from the barges into storage bins to feed to the mixer, and the cement in bags by means of conveyor belt, as shown in Fig. 2.

Details of the Kearny project, including the new cable and telephone switch board plant, as given in the *Contractor's Atlas*, include the statement that the plant will cost more than $20,000,000, and will ultimately employ about 30,000 people. The cable building alone, upon which work is now progressing and where the photographs reproduced in the accompanying illustrations (Figs. 1 to 5) were taken last December, will cost about $5,500,000, and will have a capacity for manufacturing 210,000,000 conductor feet of loop cable per week. Later the plant will be added to by the erection of a series of 6-story structures, which will have a total floor space of approximately 693,000 sq. ft. In addition to the buildings, there is being constructed a 1600-ft. bulkhead along the Passaic river.

W. R. Kattelle, the Western Electric Co.'s architect, is in immediate charge of the plans and execution of the work on the new plant. McKenzie, Voorhees and Gmelin are the consulting architects, with the J. G. White Engineering Corp. and Charles W. Staniford as consulting engineers. Henry Steers, Inc., the contractor for the foundations and bulkhead, operated the mixing plant and conveyor belt described above. The Turner Construction Co. is the contractor for the superstructure.

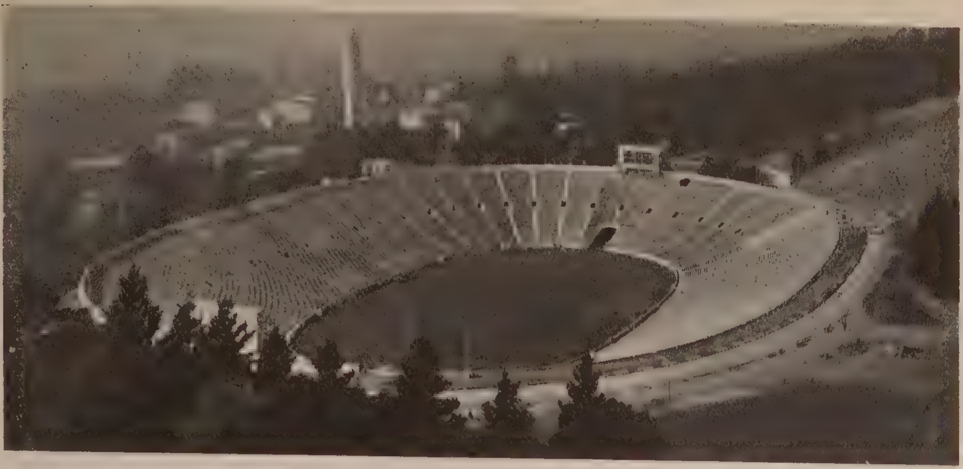


Fig. 1 — California Memorial Stadium almost Completed as it Appeared on November 5, 1923. University of California Buildings, Berkeley, and the Golden Gate in the Background

California Memorial Stadium Combines Earth Bowl and Coliseum Type Concrete Construction

The University of California Memorial Stadium in the Strawberry Canyon on the Univeristy of California campus is a combination of earth bowl and coliseum type of elliptical form. The major diameter is 760 ft. and the minor diameter 568 ft., extreme dimensions. The seating capacity is 72,800. On 62% of this area the seats are entirely supported on earth, and on the remaining 38% are supported on a reinforced concrete suspended slab and beam construction of an average thickness of 7 in. The suspended slab and beam construction is supported by reinforced concrete columns and braced longitudinally and transversely by horizontal tie beams.

The total stadium covers a sloped area of 250,000 sq. ft., and the suspended slab and beam portion covers an area 80 ft. x 1200 ft. located on the west side. The periphery of this superstructure is a reinforced concrete curtain wall 1,200 ft. long, with a maximum height of 66 ft. and an average thickness of 10½ in. A reinforced concrete score board, 50 ft. x 34 ft. in dimension, towers 35 ft. above the upper row of seats at each end of the stadium.

The general contract for the stadium was signed May 15, 1923, but owing to unforseen difficulties in the excavation, which was under separate contract, a part of the site was not turned over to the general contractor until the middle of June. A perfect building organization and the cooperation of the Stadium Commission were depended upon to make it possible to have the stadium completed for the latter part of November, 1923.

For the construction of the concrete part, the contractor's plant was installed close to the face of the exterior wall, about 400 ft. from the south end of the main concrete structure. It was originally planned to erect a second concrete plant about an equal distance from the north end of the concrete portion, but, due to a delay on the part of the excavating contractor, the second plant was not erected, but the concrete was wheeled the entire distance. The plant was made up of a 1-cu. yd. capacity concrete mixer and a 100-ft. hoisting tower, with a cement shed having a capacity of 5000 sacks storage, a 300-cu. yd. elevated gravel and sand bunker with three compartments and an inclined runway over which motor trucks dumped material into the bins.

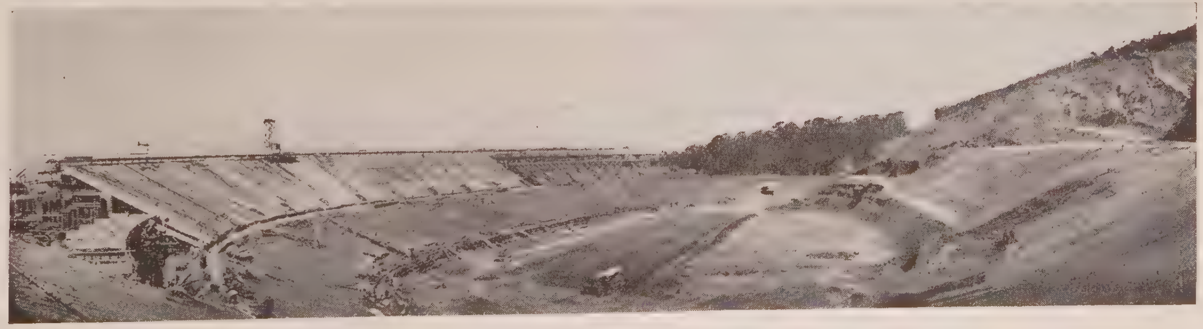
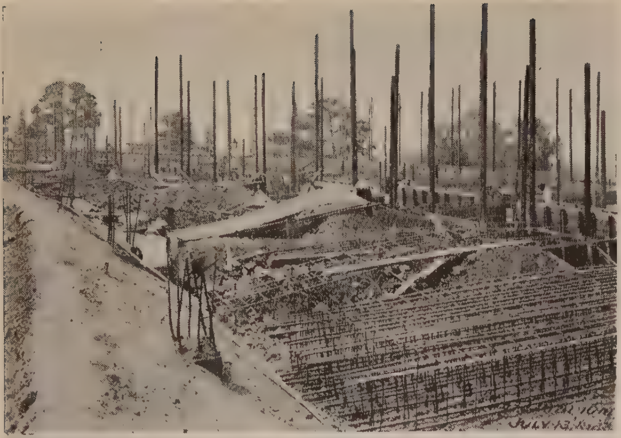
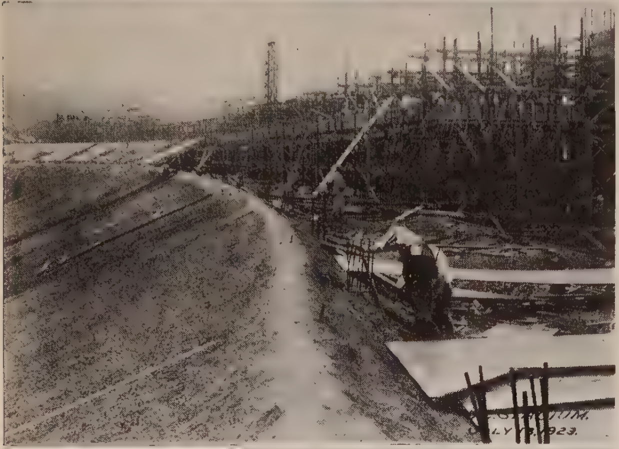


Fig. 2—Building the Concrete Portion on the Left. The Cut on the Right Was Excavated by Hydraulic Method and the Spoils Used for Fill to Support Wood Seats and Concrete Stairs in Certain Portions of the Bowl





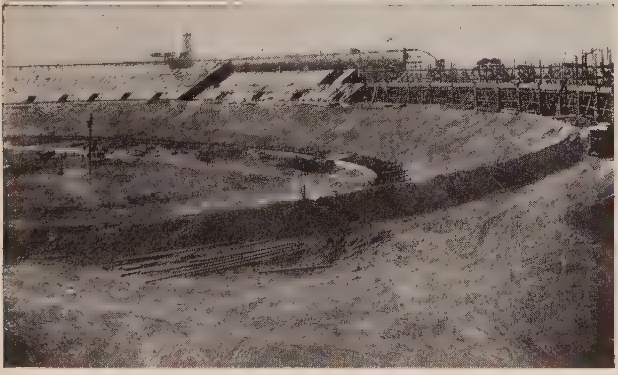
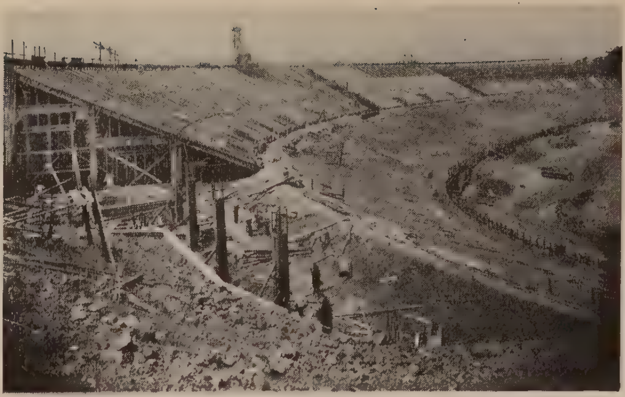
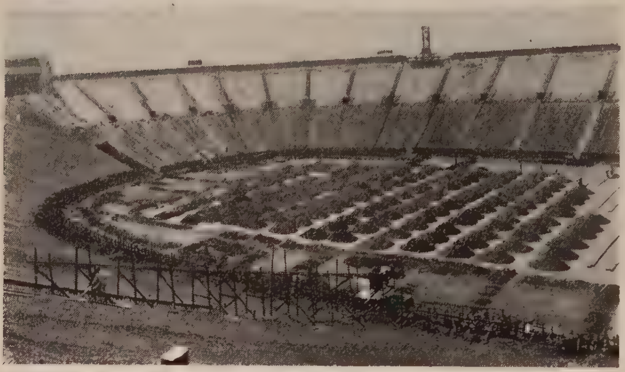


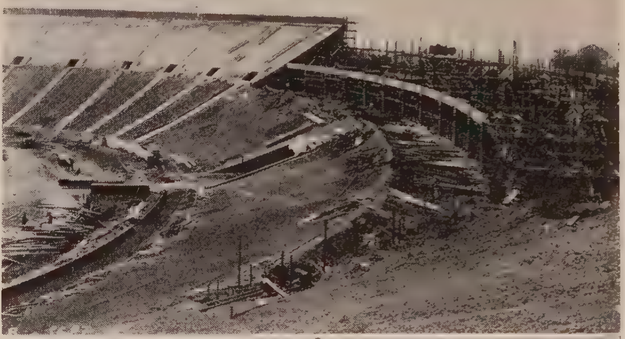
Fig. 3—Form Work for First Tier of Horizontal and Transverse Tie Beams

Fig. 4—Form Work for the Transverse and Horizontal Tie Beams and Columns

Fig. 5—Form Work for Superstructure







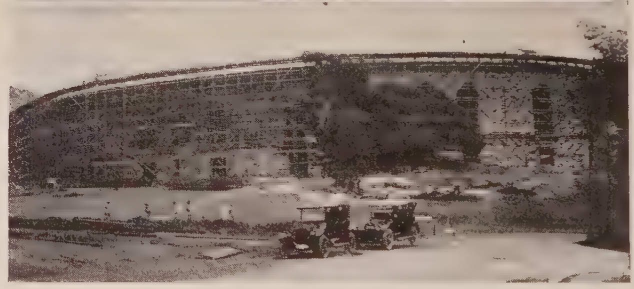


Fig. 6—Suspended Slab and Beam Construction of Superstructure

Fig. 7—Preparing Playing Field. The Final Covering for the Field Was a 10-in. Layer of Loam

Fig. 8—False Work to Support the Slope Suspended Slab and Beams. The Lower Half is Supported on Earth Fill

Fig. 9—Exterior Wall. Scaffold for Handling Materials and Wheeling Concrete as it Appeared on October 6

Owing to the many belt courses, moldings, offsets, and panels, which give the exterior the appearance of the Coliseum, and the curve of varying radii, the form work for the high wall was complicated and necessitated employment of the most able and skilled carpenters. The forms for the moldings and panels were made at the mill, and a finished surface for the concrete was attained by pouring directly against the curved forms. No plaster run work was employed on the wall. A 7-ft. wide scaffold, supported on well-braced 3 x 4 posts spaced 6 ft. o.c., constructed around the entire exterior of the wall, supported the planks for wheeling the concrete at the different elevations as needed and was also used in applying the cement dash to the walls.

As shown in the accompanying illustration, the false work for the sloping superstructure was built up of 4 x 4 shores spaced at 4-ft. intervals, well braced and wedged. In pouring the sloped slab sections, the mixed concrete was hoisted to the top elevation of the slope, wheeled in carts around the runway on the exterior scaffold, and at the proper section was dumped into sheet-metal chutes built in sections 12 ft. long, and so connected as to permit chuting the concrete by gravity to the lower part of the sloped slab. The lower part was poured first, and the sections of the chute removed as the concreting gradually worked up the slope. In order to prevent running on the slope, the concrete was mixed rather dry and was worked into place.

A similar method as that employed in pouring the sloped section was employed in constructing the isolated concrete stairs which rested on the earth on the east side. A small batch mixer at the top mixed the concrete for the stairs. The forms were made of 2-in. lumber in 14-ft. sections. The cement finish on the treads was made integral with the structural concrete by applying it soon after the concrete was poured.

The construction of the subgrade of the playing field is shown in Fig. 7. First, 4-in. agricultural tile were laid 15 ft. o. c. and covered by a 4-in. layer of 1-in. rock. On top of this was a 4-in. layer of ½-in. gravel, 4 in. of sand and a final course of loam, 10 in. thick.

During the construction period of 5 months, a crew of approximately 250 men placed approximately 7,500 cu. yd. of concrete and 600 tons of reinforcing steel. Over 1,000,000 board ft. of form lumber and 750,000 board feet of seat lumber was required. The contract was carried out by the Clinton Construction Co., of which W. B. Brinker is president. D. Ormsbee represented the Stadium Commission, and W. H. Cagle was superintendent for the construction company on the job. A. Huber, Jr., to whom CONCRETE is indebted for the foregoing information, is vice president of the Clinton Construction Co., San Francisco and Los Angeles.

How Storm-Proof Are Concrete Stave Silos?

By W. G. Kaiser

Less than one tenth of one per cent of the concrete stave silos erected in this country have been demolished by windstorms or tornadoes. This remarkable performance was revealed in a survey recently conducted by the National Concrete Stave Silo Association to determine how concrete stave silos withstood severe storms. In this survey reports submitted by 45 representative manufacturers operating in 20 different states disclosed that out of a total of 26,958 silos erected by them since they were in the business, only 24 had been demolished by storms. This loss is less than one silo in a thousand, a remarkable record considering that some of the silos have been in service for 15 years. Assuming 8 years as the average age of all silos considered in this survey, the average annual loss is only 3 silos. This is equivalent to a yearly loss of one concrete stave silo for each 9,000 in use. Assuming that the average value of each silo destroyed is $500 and dividing this loss among 9,000 silos, it amounts to less than 6¢ per silo per year.

Manufacturers reported that 32 additional silos had suffered minor damages to chute or roof, most of which were repaired at small cost. One manufacturer stated that 10 cents per silo per year would easily cover all storm damages to his silos. That his estimate was approximately correct, is shown by the figures given above.

Numerous instances were cited, where concrete stave silos had successfully withstood storms of such severity that the barn adjoining the silo, as well as other large buildings of the farmstead, were completely demolished. In the majority of cases, damage to concrete stave silos, when it occurred, was caused by a section of barn or other building being blown against the wall, resulting in the collapse of the staves. However, it should not be inferred from this that stave walls will not safely sustain heavy impacts. An instance where the wind blew one side and the roof of a barn against the concrete stave silo without injury, except to crush the metal chute, is mentioned by A. D. Conley, of the Interlocking Cement Stave Silo Co., Imlay City, Mich.

Further proof of the rigidity of concrete stave silos was furnished by Andrew Nordloef, of the Minnesota Cement Construction Co., who writes that, during the severe tornado that visited Fergus Falls, Minn., in June, 1919, a barn was blown against one of his silos with such force that the silo was shoved 15 ft. off its foundation. This silo still stands where the storm left it, and has been filled three times since, without any repairs whatsoever. Kent Merry, president of the Interlocking Cement Stave Silo Co., Wichita, Kans., reports that two large silos (18 x 50 and 20 x 50 ft.) were moved off their foundations without injury to their walls. Foundations were built under them in their new locations. This same storm blew away the houses and barns on the farmsteads where the silos were located.

The majority of the silos that have failed in storms were among those first erected, and the builders admit that the manufacturing and construction methods in use then were much inferior to present-day practices. There has been little damage done to concrete stave silos erected in recent years.

Most stave silo contractors have so much confidence in the ability of their silos to resist storms that they furnish some sort of guarantee to each purchaser. Several give an absolute guarantee against windstorms and tornadoes of all descriptions. Others give an absolute guarantee over a limited period of years—usually five. Practically all manufacturers agree to replace or repair any of their silos damaged by windstorms other than tornadoes.

Under the heading "Minor Damages," metal roofs were the principal loss. Usually the sheets comprising the roof were blown off after the rivets had been pulled out or the nuts on the bolts had become loosened. Undoubtedly much of this damage could have been avoided if farmers would take precaution to tighten up loose nuts once a year, when the silo is full. No damage was done to roofs constructed of concrete. Concrete roofs, besides being stormproof, appeared to give greater stability to the silos they covered.

Concreting Plant for Ohio River Lock

By Capt. W. F. Heavey
U. S. Army, Louisville, Ky.

The construction of the lock at Dam 45, Ohio river, at Addison, Ky., 70 miles below Louisville, Ky., is being performed by the Engineer Department, U. S. Army, by hired labor with government plant. Bids were asked for the construction of the lock by the U. S. Engineer office at Louisville on four separate occasions, but, at the time bids were asked, contractors engaged in river work had all the contracts they could conveniently handle in the upper part of the river, where working conditions and river stages were more suitable, and, as a result, no bids were received for the construction of the lock at Addison.

This lock is the standard size adopted for the entire Ohio river project, namely, 110 ft. x 600 ft.; the lift is 9 ft. The usual Ohio river type of box cofferdam was built, being completed in the 1922 season. About 150 ft. of upper guide wall and 200 ft. of lower guide wall are included in the coffer. The foundation for the lock is hard limestone. The limestone was covered by about 6 ft. of soft shale, which had to be removed. Also the hard rock inclines downward rapidly as it goes out from the bank, and, in order to have the river wall rest on the limestone, the land wall had to be set back into the bank, requiring considerable rock excavation for its footings.

The river wall has its footings at a lower depth than the land wall. The river arm of the cofferdam rests on a gravel foundation, the rock having dipped to a considerable depth when that far out from the bank. This circumstance caused considerable leakage in the river arm of the coffer. The water leaked through the porous gravel under the cofferdam rather than through the cofferdam, and necessitated the driving of a line of steel sheet piling on the outside of the cofferdam. The sheet piling reduced the leakage some, but it is still quite large, as the piling did not reach rock at all places.

The concrete problem at this lock is to pour 40,000 cu. yds. along the two walls, a land wall of 1100 ft., including the sections of guide walls included in the coffer, and a river wall of 785 ft. The river stages in the vicinity of Dam 45 being such as to limit the working season in the coffer (built for a 16-ft. stage) to an average of about four months per year, it is necessary to plan to complete all the concrete work of the year's task within that period of time. Also it is very advantageous to complete all the work in the lock coffer in one season, so that the cofferdam may be removed early and the pass coffer built to be ready for work therein at the beginning of the next working season. This necessitated planning to clean out coffer, excavate rock, prepare footings, etc., and pour the entire 40,000 cu. yds. in a four-months period.

The topography of the river bank on the lock side is particularly suited for laying tracks approximately parallel to the land wall and for storing sand and gravel. Because of this, and also in order to prepare as much as possible for concreting in advance of unwatering the coffer, it was decided to use a movable gravity plant for concrete mixing and distribution. The tracks were laid, mixing plant built, and a large amount of aggregate (about 16,000 cu. yds.) stored accessible to the mixer before river stages fell enough to allow the coffer to be unwatered. The preliminary preparations also included the building of nearly all the forms, most of which were made interchangeable, and the erection of cement sheds, etc.

The mixing plant moves on two standard gage tracks laid on 20-ft. centers, the one next to the lock being 6 ft. lower to conform to the slope of the bank and thus reduce the grading necessary for roadbed. A third track was laid on top of the bank, and 30 ft. from the upper mixer track, for a locomotive crane, which is used for feeding the sand and gravel bins from storage piles on the bank, as well as for handling to storage piles the sand and gravel which is brought up an inclined track from barges by steam locomotive and dump cars of 16 cu. yds. capacity. The upper mixer track is connected to the yard tracks, thus allowing cement in railroad cars to be moved, as received, directly to the mixer and unloaded on to an inclined belt conveyor which carries the cement to the mixing platform of the concrete plant. This reduces cement handling to a minimum, since, with mill-tested cement and a fairly uniform rate of delivery, very little of the cement received during the working season need go into the cement sheds, which are used only for the reserve supply.

The movable plant was designed and constructed by H. G. McCormick, U. S. Assistant Engineer in local charge. As the design was based on equipment and materials already in stock, it was in some ways adapted to use the equipment on hand, rather than constructed from what was otherwise considered most suitable. Essentially the framework of the plant consists of a wooden tower 50 ft. high, supported by an A-frame with stiff legs, resting on a platform of 18-in. I-beams, which in turn rests on a standard 80,000-lb. flat car on the lowest track and on three sets of trucks on

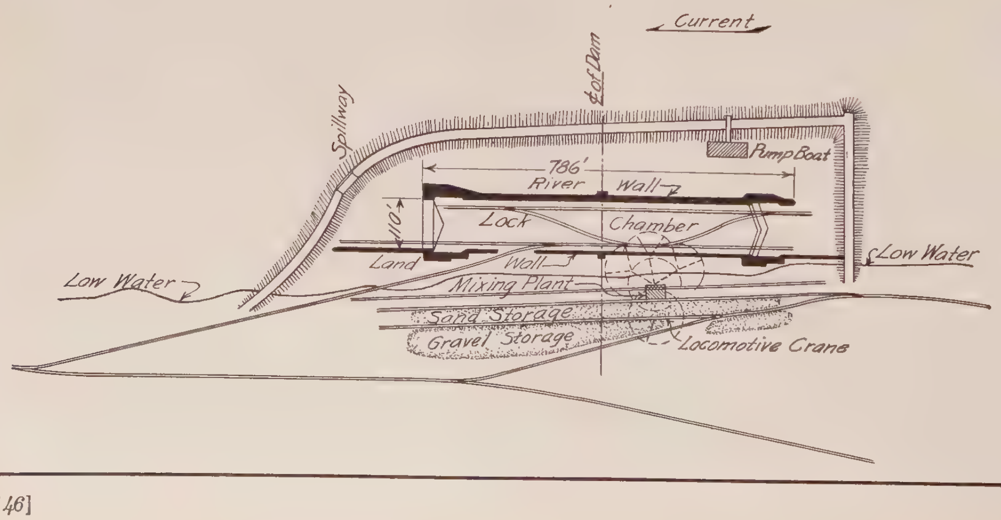


Fig. 1—General Layout of Concreting Plant at Site of Lock

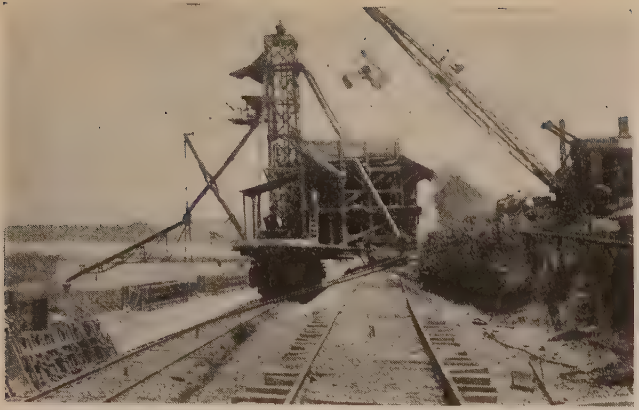


FIG. 2—MOVABLE MIXING PLANT DISCHARGING CONCRETE INTO FORMS

the middle track. The hoisting engine, mixer and engine, sand and gravel bins, and small shed for cement are all placed on the framework. The mixer itself is a Smith one-yard, non-tilting, drum type. It discharges directly into the hoisting bucket when in its lowered position at the bottom of the tower.

Current supply of sand and gravel is stored in separate overhead bins, capacity about 20 cu. yds., each of which are kept constantly filled by the locomotive crane on the upper track. These bins discharge, by lever-controlled sliding gates, into the batch or measuring hopper, the top of which was set at the mixing floor level. The required amount of cement is dumped into the hopper by hand, sack measurement being used. Water is admitted through a 3-in. pipe from a barrel fitted with a graduated gage, the flow being controlled by a quick-acting lever valve. An average of 12 to 15 revolutions of the mixer are made, and the mixing is further assisted by the mixing in the hoppers and chutes after leaving the mixer itself. The mixer has been worked continuously for as long as an entire shift, eight hours.

The lower lifts of the river wall, the upper and lower miter sills, the land wall and the sections of the guide walls included in the coffer are poured direct from the concrete mixing plant by chute. With the plant as designed, it is necessary to rehandle the concrete for the upper lifts of the river wall. This is done by locomotive crane and bottom dump buckets. It would have been possible by increasing the height of the tower on the mixing plant to pour the upper lifts of the river wall direct also, but it was decided that, as the yardage involved was not large and as the use of bottom dump buckets would not delay the pouring to any great extent, it would be more economical to limit the height of the tower to 50 ft. and rehandle the concrete for the upper lifts of the river wall.

The maneuvering of the boom and counterweighted extension chute is very easily done, and great flexibility in placing the concrete at any desired point in the forms is obtained. Care was taken in the design to place the pivot points at the foot of the boom and the chute connection to the tower hopper, as well as the boom line connection at the top of the tower, all in the same vertical line. This permitted the boom to swing freely through 180°, while the counterweighted extension chute had a swing of 360°, thus allowing the discharge spout to reach any point near the plant except the small area directly in its rear.

The boom chute and the counterweight chute are each 48 ft. long. A slope of 1 on 3 is used, thus making the extreme reach of the chute about 90 ft. horizontally from the receiving hopper. By adding additional chutes this is increased as desired, though with some loss of flexibility. Changing the location of the plant on the tracks is only a matter of a few minutes delay, the handling being done with a 25-ton locomotive. The results obtained with this plant are satisfactory. Delays are infrequent and never of long duration.

The plant and methods described possess the following advantages:

(a) All preliminary work necessary for the actual placing of concrete can be done prior to the opening of the construction season.

(b) A large amount of aggregate can be secured in advance of the rush season and stored accessible to the mixer without rehandling.

(c) Non-interference of concrete operations with other work inside the lock chamber.

(d) Elimination of concrete tracks and handling equipment inside the cofferdam.

The cost of the concrete placed indicates that this method of concrete distribution is cheaper than that used on similar work elsewhere. The total unit cost of the first 28,000 cu. yds. was less than $9.00 a yard, and the unit cost of mixing and placing the concrete was only $1.50 a yard, after distributing the net cost of the mixing plant over the entire yardage to be poured with it.

The concrete specifications for this lock call for a 1:3:6 mix for the mass concrete, but for a facing 6 in. thick of 1:1½:3 mix on all surfaces exposed to wear by boats, ice or drift. These specifications require a rich facing on tops of river, land and guide walls, at vertical faces of lock chambers and of exposed walls above a plane 5 ft. below pool level. Facing boards, usually about 2 ft.x 3 ft., placed parallel to the form and held away from it by iron separators 6 in. wide are used. The rich concrete is placed by shovel behind these facing boards, and they are then raised by ropes, sliding along the side of the form, and the operation is repeated when the mass concrete is poured up to the level of the facing boards.

The purpose of this 6-in. facing is, of course, to place strength and density where it is needed to resist wear, and to permit the mass to be made in the more economical 1:3:6 mix. Prior to the adoption of the facing, all mass concrete above pool level was mixed in a 1:2:4 proportion, but it is believed the 1:1½:3 mix is more desirable. However, there is some question as to whether the requirement of a 6-in. face is worth the trouble and expense of placing it. Some think it would actually be less expensive to use the rich mix for the entire portion of the concrete above pool level. They give the following objections to the use of a 6-in. facing:

1. The dense concrete can not be dumped by bucket

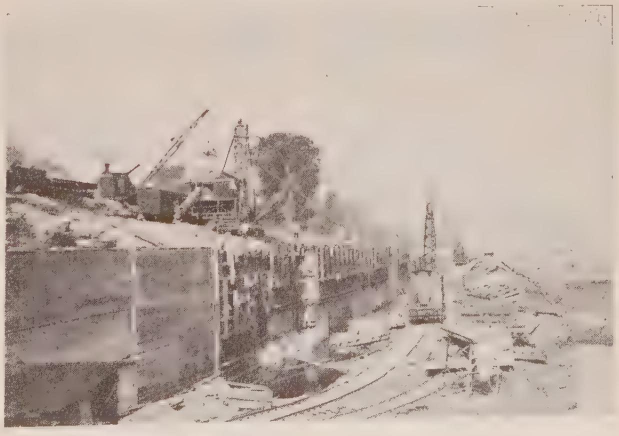


FIG. 3—LOCK WALL UNDER CONSTRUCTION. MIXER ON HIGH GROUND AT LEFT

or chute behind the facing boards, but must be shoveled by hand, thus causing extra labor costs.

2. The same mixing plant has to turn out different mixes, thus causing delays and misunderstandings.

3. Time is lost in placing and handling the facing boards.

4. Numerous tie rods, special forms, and spacing struts in the forms interfere with the placing of the facing boards.

One method of procuring practically the same result is to dump or chute the richer mix in close to the forms, and thus have a denser face without having to use facing boards and without the labor of shoveling, etc. This method, of course, gives a facing thicker than 6 in. and of irregular thickness, but its advocates claim it is cheaper, easier and quicker, and results obtained are as satisfactory. Another method advocated is to spade in some extra cement by hand, next to the forms. It is claimed that the concrete from the mixing plant is wet enough to absorb a good deal of the cement. This last method, however, has the objection of large labor cost from handling and spading, and there is some doubt as to how much of the cement will actually mix into the concrete if the concrete is of the right consistency and not sloppy.

For protecting the horizontal top corners and the vertical 90° angle corners of the concrete masonry, round back angles, 3½ x 3½ x ⅜ in. were specified. As the round back angles could not be obtained in a reasonable length of time, standard angles were substituted, the corners being machined to a 1-in. radius. The corner protection angles are anchored into the concrete by bar anchors $\frac{5}{16}$ in. x 2½ in. placed 2 ft. apart on each leg of the angle, the anchors extending 6 in. back into the concrete.

Hydrated lime in the proportion of half a sack (50-lb. sacks) to the batch was added to the mix, the lime being an admixture not a replacement. The extra cost of the lime, 20¢ per yd. of concrete, was more than paid for by the following advantages:

1. Excess water entirely disappeared, being absorbed in the hydrated lime.
2. Flow in the chutes was freer—no choking of chutes.
3. The concrete was more workable in the forms.
4. The surface of the concrete was smoother, denser, and more uniform.
5. There was less segregation of aggregates, fewer and smaller gravel pockets and honeycombs.

Work in the coffer was interrupted from Aug. 17 to 27, due to a sudden and unexpected rise in the river when a 20-ft. stage was reached, topping the coffer by 4 ft. Despite this delay, practically all the concrete work was completed by Nov. 29, when the end of the working season arrived.

"Can We Cut Down the Curing Period for Concrete Roads?"

By H. F. Clemmer
Engineer of Materials
Illinois Highway Division

From an address at American Roadbuilders Association Convention, Chicago, January, 1924.

Considerable interest is being evinced by highway engineers throughout the country in a method for curing concrete pavements that will do away with the ponding and other wetting methods that are not only cumbersome but require a curing period of 30 days.

Materials and methods for curing concrete and accelerating its set have been the object of considerable research in many of the laboratories of the country. Methods and materials commonly in use today are those requiring at least 28 days during which time the road is necessarily closed to traffic. If this period were to be reduced to 14, or even 21, days the saving to the travelling public which could be effected is worthy of mention.

Prof. T. R. Agg of Iowa State College in a recent report to the Advisory Board on Highway Research included valuable compilations relative to the economic phase of the development of highway construction. In this report, one table of particular application to the subject of this paper, contains the operating cost of various types of cars over all types of roads. As given in this table, the cost of operating a passenger automobile over ordinary earth roads is 12.6 cents per ton-mile as compared with a cost of 9.3 cents over a good concrete pavement, making the difference in cost of operation 3.3 cents per ton-mile, or an average of 4.1 cents per car-mile, considering the average weight per car to be 2500 pounds. In order to demonstrate the saving which may be effected by a shorter construction period we may assume that a state constructs 1,000 miles of pavement necessitating 1500 miles of detour; that there is an average daily traffic of 500 cars. By calculating on a basis of the operating costs mentioned above it is found that a saving of $900,000 to the motorists is secured if the construction period is cut down 15 days. This astounding sum as well as many of the worries incident to detouring is saved to the motorist and the cost of detour maintenance is saved to the state if the time required for the proper curing of concrete can be reduced from 30 to 15 days.

The need for a method of curing concrete pavements without the use of water becomes evident when a number of road builders adopted the central mixing plant method of construction, under which method it was sometimes necessary to transport water either by tank or pipe line for the purpose of curing alone. The absence of sufficient water in many localities was also a factor in incresing the curing cost on many jobs. In cold weather construction the importance of securing a quick set and early strength was apparent when it oftentimes became necessary in low temperatures to replace canvas or straw protection before the set was reached, under normal conditions. All of these factors suggest the urgency which caused the investigation in regard to an accelerator and curing agent for concrete. This paper reviews the investigations which were begun by the Illinois Division of Highways in 1921 on the use of calcium chloride as an accelerator and curing agent for concrete and have led to the adoption of this chemical for highway construction in this state.

A preliminary report of this investigation was presented at the 1923 meeting of the A. S. T. M.

The use of chemicals for accelerating or retarding the set of concrete is a practice as old as the manufacture of portland cement. Those methods which have been the most thoroughly investigated show that calcium chloride when used in the proper amounts does accelerate set and secure the same strength at the end of 14 days as can be obtained from the use of the various wetting methods in 28 days. The opinion of many engineers has been that although an early strength is secured, a retrogression of this strength occurs later. No long time tests have previously been available but the Illinois Division of Highways at the time of the preparation of this paper has broken two-year specimens the results of which tests disprove this theory regarding the retrogression of strength and, we believe, removes the most serious objection to calcium chloride curing.

The exact theory of the action of calcium chloride in accelerating the set or curing of concrete is possibly as remote as the theory of the setting and hardening of cement. Roughly, the action of this chemical is dependent upon its hygroscopic properties and its resulting ability to attract moisture from the air. Due to this same property moisture is also taken from fresh concrete, minute capillary channels resulting in its movement to the surface. It is thought that the calcium chloride in turn is drawn into these channels and in this manner penetrates the concrete for considerable depth and insures the presence of sufficient water for the hydration of the cement regardless of whether the material on the surface remains or is carried away by rain or other agency. This penetration of the chemical into the concrete apparently takes place within twelve hours as tests later demonstrate.

Another objection which has been raised to the use of calcium chloride is that the surface of concrete which has been treated with this material scales and oftentimes becomes "mushy." It has been the experience of the Illinois department in the investigations made for this purpose and in the curing with calcium chloride of over 1000 miles of concrete pavement that no more serious cases of scaling have occurred on concrete cured with the chemical than on concrete cured by earth or other similar methods. The results of one phase of this investigation concerned with the causes of scaling definitely assign the most serious cases to excess tamping or belting.

The work of the Illinois Bureau of Materials involves the use of over 2000 specimens and includes the testing of transverse strength of over 500, 8 x 12 x 30 in. beams, 100 cylinders, 6 x 12 in., made to serve as a check on the quality of the concrete, 1000, 2 x 4 in. cylinders and tensile briquettes of 1:3 mortar and neat mixtures, and in addition several slabs of various size and type for determination of wear and extent of scaling.

For convenience in reporting and interpreting results, the investigation was conducted along two lines, external and internal treatments, and are reviewed in this order by this paper.

External Treatment

In the investigation of the effects of using surface applications of various types and amounts of curing materials, over 500 slabs, 8 x 12 x 30 in., were subjected to these treatments and tested at the several ages for transverse strength. Cylinders 6 x 12 in. were used as control specimens to check, in compressive strength, the concrete used in making the transverse specimens. The volumetric mix, 1:2:3½, the standard adopted by Illinois for highway construction, was employed. All portland cement, sand and crushed limestone was tested in accordance with the state specifications.

Since the primary interest was in the strengths obtained in 14- and 28-day periods the greater number of specimens were tested at these ages. However, for the purpose of determining whether or not retrogression in strength occurred at later ages, 60-day, 90-day, 6-months, 1-year and 2-year specimens have also been tested.

Carefully controlled methods, consistency of mix, graduation of materials and the fact that the same operators made all specimens insured the uniformity of concrete. In all of the work on curing, the modulus of rupture has been considered as a true indication of the completeness of curing. In the curing of a slab 8 x 12 x 30 in., pavement conditions are duplicated in the amount of surface treated. No attempt was made to cure compressive cylinders by any surface treatment.

An explanation follows of the treatment and results of the series of experiments in surface applications; in addition, the description of the tests and results for the determination of effects of various treatments on wear, scaling, change in weight and volume and other characteristics of concrete.

Series 1—This series included 260 specimens, of which 100 were poured in holes in the ground having side boards only, 60 in oiled wood forms in the basement of the laboratory, and the remaining 100 in concrete forms. These latter forms were constructed of 1:4:5 concrete with walls 3 in. thick and 8 in deep and were allowed to set for 48 hours before the curing specimens were poured. The object in using these concrete forms was to provide a condition which would approximate the curing of a pavement slab, that is, of concrete against concrete.

Care was taken to cover all specimens with a canvas immediately after they were poured to provide protection against weather conditions. All specimens were finished with a trowel and were given their curing treatments the day following.

The specimens in this series received the following treatments: 2 in. of dirt wet 3 days; 2 in. of dirt wet 7 days; 2 in. of dirt wet 14 days; 1 lb. per sq. yd. of calcium cholride; 1 lb. per sq. yd. of calcium chloride with 1 in. of dirt; 3 lb. per sq. yd. of calcium chloride; 3 lb. per sq. yd. of calcium chloride with 1 in dirt ½ to 2/3 gal. of asphalt per sq. yd.

Series 2—The specimens in this series were poured both in oiled wood forms and in concrete forms. The effect of an oiled subgrade as well as the use of magnesium calcium chloride and sodium silicate as curing agents, was investigated in this series.

The specimens in this series were given the following treatment: 3 lb. per sq. yd. of calcium chloride after 10 hours; 3 lb. per sq. yd. of calcium chloride after 24 hours; 3 lb. per sq. yd. of calcium chloride after 10 hours, washed off 12 hours later; 3 lb. per sq. yd. of magnesium calcium chloride after 10 hours; 3 lb. per sq. yd. of magnesium calcium chloride after 24 hours; 1/5 normal solution of sodium silicate after 10 hours; 1/5 normal solution of sodium silicate after 24 hours; 2 in. of dirt wet 7 days; 2 in. of dirt wet 14 days; 2 in. of dirt wet 7 days (subgrade oiled). These specimens were tested at the age of 14 and 28 days.

Series 3—In this series specimens were cured with surface treatment of various forms of calcium chloride in order to compare the effect of using calcium chloride with that of using solutions of the chemical. In the same series, results were also obtained as a comparison of both flake and granulated forms of dry calcium chloride.

As a result of the three series of tests as outlined above several charts comparing the relative curing values of the various methods of curing have been drawn. These results may be interpreted from several angles but considering the text of this paper the most valuable and significant comparisons to be drawn are those that demonstrate the ability of calcium chloride curing to obtain as great a strength in 14 days as is received by the use of wet earth in 28 days.

Results prove ability of calcium chloride curing to gain quick strength in concrete. To obtain additional information on the effect of adding the calcium chloride at different times after the concrete was poured, slabs were treated with the material both 10 and 24 hours after making. An experiment was also included to learn the effect of washing the calcium chloride from the slab after it had remained a short period of time. This latter experiment was made to approximate a condition which would obtain in practical work if a rain washed the curing material from the pavement surface shortly after application. The surface of the experimental slab was given a good washing with running water and the calcium chloride entirely removed after it had remained 12 hours. The results show that although removed at this time, the chemical had apparently been absorbed partially by the concrete and a 28 day strength as great as that obtained by wet earth or other recognized treatments secured.

Magnesium-calcium chloride and sodium silicate, although apparently satisfactory as curing materials for 28 day periods do not exhibit the properties that secure early strength.

The results of tests on Series 3 are confined to the comparison of the effects of surface applications of dry calcium chloride as compared with the external use of solutions of the chemicals. Three lb. per sq. yd. of the dry chemical was found to be far superior in this experiment, specimens cured in this manner having a modulus of rupture much greater than those treated externally with the solutions of both 60 and 30 % calcium chloride. It was thought that if the method was found satisfactory, application of a concentrated solution of calcium chloride would be somewhat more convenient and uniform than treatment with the dry material.

A second comparison made by the tests in Series 3 was that between the strengths obtained from the use of the flake and granular forms of calcium chloride applied dry. Practically no difference was found by test in the results obtained from the use of either type of material and in the practical use of the material there has been found no distinct advantage in discrimination.

Properties of Calcium Chloride Applied Externally

The hygroscopic properties of calcium chloride enable the chemical to attract moisture and when the material is spread evenly and in contact with both the air, containing moisture, and the surface of the pavement slab the resulting action of transferring mositure is fundamentally apparent. Also, as previously explained, it has been observed that the calcium chloride attracts moisture from the concrete causing by this action minute channels through which the calcium chloride, in solution, is in turn drawn back into the concrete. This second action has been advanced as a result of the observation of small capillary channels leading to the surrace and a noticeable penetration of calcium chloride.

In order to determine the extent of this action, mortar specimens of the same weight were made and treated with varying quantities of calcium chloride including a series of specimens having no treatment. In order to insure against loss of moisture by absorption in the contained, these samples were made up on tin plates. After being treated, these samples were weighed at intervals of one hour and loss or gain in weight calculated.

A weight greater than the original was observed on all treated specimens for a period of as high as 45 hours, the untreated specimens however, exhibiting an immediate loss. The fact that this action is proportional to the strength of the treatment is also apparent and leads to the theory that the hygroscopic chemical freshly applied attracts moisture from the air in proportion to the amount used until the absorbed moisture is in equilibrium with that of the air, after which, by absorption into the concrete and loss by mechanical means, the amount of chemical and necessarily water gradually decrease. This property of calcium chloride to maintain the moisture content of the concrete at a higher percentage during the first 48 hours, leads to the belief that the chemical serves to prevent the formation of transverse cracks caused by shrinkage. General observation indicates that fewer transverse cracks occur in concrete pavements cured with calcium chloride than those cured by ponding or wetted earth. This is being definitely investigated in Illinois at the present time. If found true, this fact alone would warrant the application of this material as a curing agent.

Laboratory investigation was made to determine the effect on surface of concentrated amounts of calcium chloride. To illustrate the various effects, tensile briquettes of 1:3 mortar were made and treated. The broken briquettes show clearly the penetration of the chemical and the puffing or scaling caused by the use of concentrated amounts. These specimens were treated with a surface application of the dry chemical that would amount to about 10 lb. per sq. yd. of surface. It should be noted that the tensile strength of these briquettes at the age of 28 days was not affected by the excessive amount of calcium chloride. Contractors are cautioned, however, against the use of excessive quantities and are instructed to break all lumps and spread the material evenly on the surface. Very little labor is required for the operation. The method of application has been left to the contractor or resident engineer and there have been developed as a result, several implements and methods by which the calcium chloride may be spread. The only requirement of the department, however, is that a uniform application be made.

Table 1 gives the results of a series of tests made in the laboratory for the determination of the cause of scaling. This series of tests included the treatment of 26 slabs, 36 x 36 x 6 in., cast in forms placed in the ground on a level with the surface. The batches were carefully designed and the standard mix of 1:2:3½ used. Application of the calcium chloride was made after periods of both 8 and 12 hours, those slabs receiving the solutions of the material being cast with a slight elevation at the edge to form a trough. Two degrees of tamping were used, that ordinarily employed in the preparation of laboratory samples and an excessive treatment in which three minutes of continuous uniform blows were imposed with a metal tamper having a face 8 x 8 inches and weighing 17.5 pounds. The same operator made all specimens as a precaution against any variation due to personal error. Confirming the observations which have been made in the field under practical conditions, the laboratory tests clearly show that the concentration of calcium chloride used in curing is not the important factor in scaling but that the degree of tamping is for the most part the cause. This is due, no doubt, to the fact that under the continuous impact blows of the tamper the relative position of the aggregates is disturbed, segregation of the various sizes occurs, the inert fine materials are brought to the surface and scaling results regardless of the method of curing which follows.

Wear of Surface

To gain an insight into the wearing value of the treated surface of concrete pavements, several slabs have been made and at various intervals these specimens have been tested in a machine designed especially to approximate the wear of a concrete pavement. The specimen is clamped horizontally to the frame of the apparatus and wear is caused by the abrasion of two metal weights kept in circular motion by a moving arm driven mechanically. A constant flow of standard abrasive material precedes the weights. The depth of wear is determined at intervals by Ames dials using reference points on the specimen.

A surface treated with 2½ lb. per sq. yd. of calcium chloride and one receiving no treatment were compared. The treated surface shows an almost imperceptible wear of .024 in. while the untreated surface shows a distinct depth of abrasion of .20 in. under the same number of revolutions of the apparatus. These specimens were of exactly the same consistency and both had the same water cement ratio. The strength specimens were made at the same time and tested at the same time as the wear specimens. A distinct and appreciable advantage in favor of the calcium chloride specimens was observed.

This wear test is more indicative of the quality of surface concrete than the various tests involving the measurements of penetration into the surface of a steel ball under impact or other force, due to the fact that, although the concrete may yield to some such penetration test, and apparently be soft, its resistance to abrasion may be greater than indicated by ball penetration. The compressive and transverse tests made in conjunction with the determination of wear are checks on the quality of concrete used in making the specimens and again illustrates the superiority in strength of the chemically cured material.

Use of Calcium Chloride in Construction

Resulting directly from the experiments with calcium chloride the Illinois Division of Highways recommends the use of the material for curing concrete pavements, about three-fourths of the total mileage constructed in 1923 being cured in this manner.

In order to acquaint the contractors and resident engineers with the proper use of the calcium chloride and furnish information on the various precautions to be observed, a general circular has been issued containing the following instructions on the surface application of calcium chloride:

> Calcium chloride may be used in connection with curing of pavements, taking the place of the usual curing with earth and water, or the curing with water by what is known as the "ponding method." Two and one half pounds of the flaked or granular material (the flaked is preferred as it is more easily distributed and less easily removed by wind or rain) shall be applied to each square yard of pavement and it shall be distributed uniformly over the surface of the finished pavement by means of a mechanical drilling device or by the use of shovels and long-handled brooms. The material shall not be spread upon the pavement until the latter has thoroughly set—ordinarily from 6 to 8 hrs. after laying the pavement. Care shall be taken that the material is uniformly spread and if, in the opinion of the engineer, a uniform distribution is not obtained from the shovels, a thorough brooming shall be required. All lumps shall be broken up and uniformly distributed over the surface.
>
> Calcium chloride shall not be applied during rain and experiments have definitely determined that if a rain follows the placing of the calcium chloride after a period of 2 or 3 hrs. there will have been enough absorption of the calcium chloride by the new pavement preceding the rain so that there will not be required additional applications of the material.
>
> Although the water line for curing of pavements with water may be omitted where central mixing plants are operated and calcium chloride is used in curing; nevertheless the general specifications with regard to wetting of subgrade and the general specifications with regard to placing the burlap on the freshly deposited concrete and wetting of burlap shall be strictly enforced. The use of calcium chloride for wetting the subgrade will not be permitted. When calcium chloride is used in curing, the sides of the concrete pavement shall be banked with earth as soon as the forms are removed.

Internal Treatment

The work on internal treatment or incorporation of curing materials with the mix has not had the direct practical bearing on the curing of concrete pavement as has the work done on surface treatment. It is apparent that if as satisfactory strengths were obtained from the incorporation of curing agents as are secured by the external application of the same materials, the internal treatment would be slightly more convenient as well as the more easily controlled of the two methods. However, early indications were that the greater strengths of concrete were to be secured by use of external application. In view of this fact the investigations on incorporation of curing materials have been chiefly concerned with their effect, in various concentrations, on the physical and chemical characteristics of cement, cement mortars, and concrete; such as setting time, internal temperatures, and strength under low temperatures. Several other experiments concerned with the rate of hydration of cement, the effect of regrinding as well as other theoretical considerations in the setting of cement have been conducted as work supplementary to the more important strength tests.

It is being held in mind as a subject for future research and investigation that it may be possible through regulating the set of concrete by the incorporation of calcium chloride to control the workability of the mix and in this manner secure with less effort on the part of the contractor a more perfect machine finished surface.

Illinois specifications now state that calcium chloride should be incorporated with the mix during the low temperatures in a not greater quantity than 2% by weight of cement. This acts as an accelerator to hasten the set so that protecting materials such as canvas and straw may be used more promptly without marring the finish, and is an assurance that the concrete will gain proper strength in the time allowed before the pavement is subjected to traffic.

It has been quite definitely shown that an early strength, suffering no retrogression over long periods, can be secured by the use of calcium chloride applied to the surface of a pavement. The results of the Illinois investigations are based on a number of specimens so great and a variety of conditions so inclusive that any doubt as to their substantiality is removed. By carefully duplicating pavement curing conditions in these investigations and accurately determining all the physical characteristics important in the life and strength of a pavement slab, we have met each objection to chemical curing by an experiment covering the details of that objection and have proved that not only are the proper transverse and compressive strengths obtained in half the ordinary curing period but that a better wearing surface with no increase scaling is the result. These investigations are substantiated by the observation on over 1,000 miles of pavement in Illinois cured by use of calcium chloride.

The results obtained so far by no means limit the extent to which further investigation may be continued or the problem to which chemical curing may be applied. Several laboratories as well as the Illinois Highway Laboratory are conducting work on the curing of concrete which will no doubt prove of great value in the future. Experiments have progressed to a point, however, where the question of cutting down the curing period for concrete pavement can be definitely answered.

Considering the actual case of a state that has built or may build in one year 1,000 miles of concrete pavement, our comparison of costs shows that the saving of two weeks on the curing period would effect a saving to motorists of $900,000 a sum large enough, at prevailing prices, to construct 30 additional miles of pavement.

Using Trolley Wire for Reinforcing

By G. H. McKelway

The use of bronze alloy trolley wire for reinforcing was resorted to last spring in one of the large power stations of the Brooklyn Rapid Transit Co., New York City, where it was necessary to install a large number of reactors in connection with the high tension switchboards. These reactors are made by winding long coils of heavy copper wire around cores composed of concrete or porcelain and insulated by the same materials.

The usual practice has been to space these reactors so far apart that their weight could be carried safely by the ordinary concrete floor, but, in this case, there was but little room for them, so that they had to be placed on considerably closer centers than is ordinarily done.

Their weight, thus spaced, would have been too much for the floor which it had been expected to use, and therefore it was necessary to reinforce it. The ordinary iron reinforcing rods could not be used, because, being so close to the alternating currents flowing in the reactors, stray currents would be set up in them and they would become very hot. As it was, an iron floor beam that was some distance away from a few of the reactors that were first put in service became so warm that there was no question that it would be impossible to use iron rods for reinforcing the concrete.

It was then proposed to use square bronze rods, but it was found that the delivery upon them would be very slow, and it was necessary to finish the floor and put the equipment into service as soon as possible. The power station supplied current to a street railway system, and the electrical engineer proposed that trolley wire be cut up and shaped instead of the rods. Calculations were made, and it was found that a large size trolley wire, of which there was plenty on hand, would make a very good substitute for the reinforcing rods.

At first it was planned to use old lengths of wire that had been used on the lines, but it was found that the section of these old pieces was not regular enough, and that therefore they were not strong enough throughout their entire length. New wire was used, which proved to be entirely satisfactory. The floor was poured with it as reinforcement, and there was no trouble from the wire heating, except where, through careless work, two or more pieces had been allowed to touch. In such cases the wire formed a closed circuit and currents were induced in it. When carefully placed, there was no trouble caused from the heating.

As there was no regular apparatus available for bending the wire, it was bent around bolts set into holes in planks prepared for the purpose. The wire used was not hard drawn copper, which is the material from which much trolley wire is made, but was a bronze alloy and about 50% stronger than the usual copper trolley wire. The great difficulty in bending it was because the wire was springy and hard to keep in shape after it had first been bent.

Write Concrete about your new labor-saving "kink."

Reinforced Multi-Arch Dam Design Adopted by Swedish Engineers

By Major Johnstone-Taylor
Lymm, England

In connection with the damming of the Great Lule river in Lapland for water power purposes, the engineers for the scheme decided that the most economical type of dam was the multiple arch design constructed of reinforced concrete.

These particular structures, of which they are two, one having 23 arches and one 15 arches, are of a type of dam wherein the water pressure is taken by a number of arched surfaces of comparatively small span supported on the downstream side by buttresses as opposed to that form of construction which, making use of horizontal stays, has the buttress pillars so reinforced that any tendency to spread is wholly resisted by those stays.

General Lay Out

Fig. 1 gives a section of the dams, from which it will be observed that the upstream face has a 45° slope, while the downstream buttress is carried up at a steep batter. Attention is drawn to the dotted line on the upstream side. This represents the line of compensated filling. The object of this filling on the upstream face is two-fold, that is to distribute any possible ice pressure and to provide some insulation against very low temperatures.

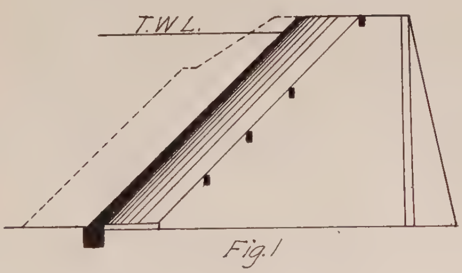


Fig. 1

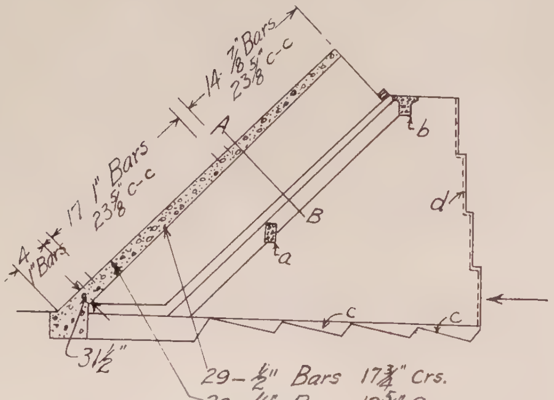


Fig. 2

More detailed typical sections are given in Figs. 2 and 3. From Fig. 3 it will be seen that the center to center distance of the buttresses is 39 ft. 4½ in., while Fig. 2 shows the arches set at a slope of 45° and having a varying thickness, the maximum being 31½ in. Fig. 1 shows the dam at its full height with four ties, and Figs. 2 and 3 show it at its present height, arrangements being made for raising the dam approximately 17 ft. at a later date.

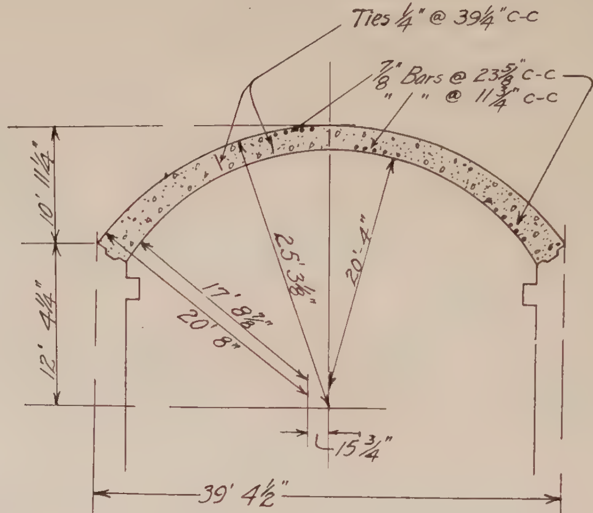


Fig. 3 (Section AB Fig. 2)

Buttresses and Ties

The buttresses are set into the solid rock foundation by means of the steps or notches *c c* (Fig. 2), and they taper upwards in thickness, the minimum thickness at final height being 31½ in., the side batter being 50 to 1. An elevation of the buttresses looking in the direction of the arrow in Fig. 2, is given in Fig. 4, showing the ties *a* and *b*, while Fig. 5 (a) shows a section of tie *a*, and Fig. 5 (b) a section of tie *b*. Fig. 6 shows the junction of the arches with the buttresses, the latter being finished on the upstream side with grooved skew backs, as at *a* Fig. 6, into which the arches are molded, similar grooving being left at *d*, Fig. 2, for the purpose of ensuring good contact with the material to be subsequently added. The usual projecting ties are, of course, left at this point, these being mainly ⅞-in. bars, the main bars in both buttresses and ties being 1-in. bars.

Arches

The arches are neither true circles nor ellipses but a combination of the two forms, the various center distances being shown in Fig. 3. It will be observed that the thickness tapers, this being arranged for by changing the radii to which the arcs of the underside are struck. The disposition of the inner and outer circular reinforcement is shown in Fig. 2, while the

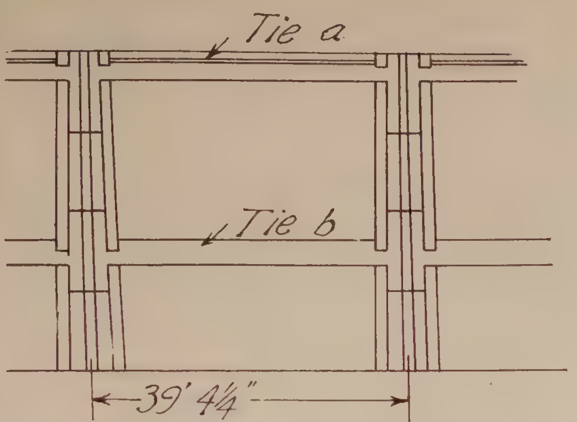


Fig. 4

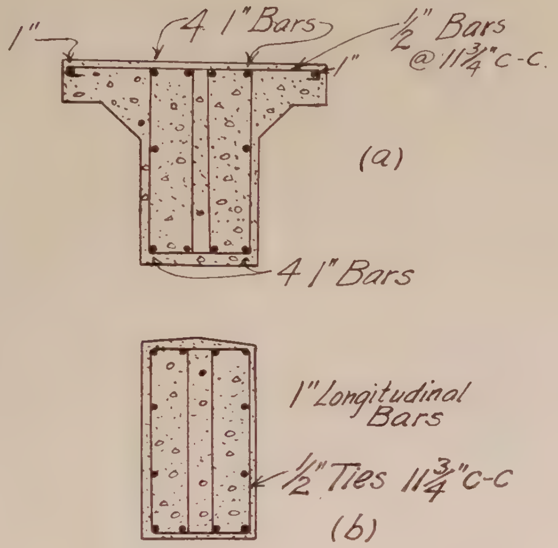


Fig. 5

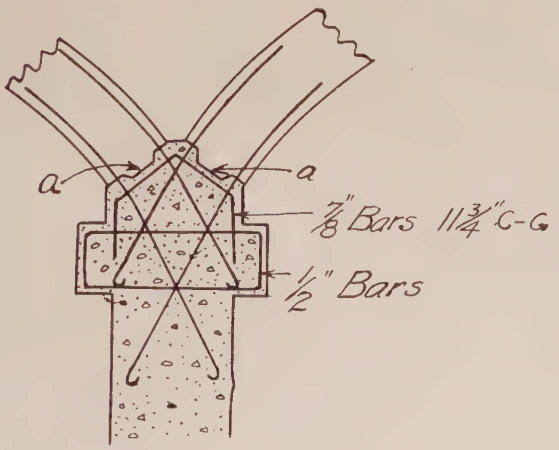


Fig. 6

vertical bars running at right angles thereto are shown in Fig. 3, where it will also be seen that there are ¼-in. cross ties at 39¼ in. on centers.

SPECIAL PRECAUTIONS AGAINST LOW TEMPERATURE

In view of the location of the work, special precautions were taken to guard against the ill effects of very low temperature. In calculating the effect of variations of temperature upon the arches, an allowance was made with the reservoir empty of 15° C. for the lowest parts, where the thickness is 31½ in., and for 25° C. for the upper portions, where the thickness is 17¾ in. in the finished dam.

At intermediate points the temperature variation was taken as proportional. It is estimated that with the reservoir filled the lowest temperature of any concrete in the archwork will be 6° C. below zero, and the lowest temperature of the water about plus 4° C. The lowest estimated temperature of the two surfaces of the work is put at 12½° C. under conditions of lowest air temperature. An allowance for contraction in hardening of 0.05 mm per metre was allowed for, the concrete being kept wet for two months after pouring. The maximum compression in the concrete allowed for was 782 lb. per sq. in., and the tension in the steel 2,133 lb. per sq. in. To cope with ice pressure, the filling before mentioned has been provided for, and it will be placed in position if thought advisable. Its object is to distribute the load over the structure, so as to reduce local excess pressure. This filling is estimated as being capable of supporting without displacement about 26 tons per ft. run, while the greatest pressure due to ice load is not anticipated to exceed 18 tons per ft. run.

Traffic Forces on Highways

The report of the Committee on Structural Design of Highways, of the Advisory Board on Highway Research (A. T. Goldbeck, U. S. Bureau of Public Roads, Chairman), included a statement of "Forces on Pavements Resulting from Traffic," briefly digested as follows:

Preliminary tests of the Bureau of Public Roads indicate that when driving over a typical concrete road at high speed with a fully loaded 2-ton truck, we may expect impact values of approximately 20,000 lbs., or over five times the static load on one rear wheel. With a fully loaded 5-ton truck at high speed, we may expect forces of 35,000 lbs. to 40,000 lbs., or over four times the static load on one rear wheel. If a downward movement of the loaded truck body occurs at the same instant as an impact, the two forces are of course additive, and the result may be double the impact. Therefore, under certain bad surface conditions a total force of 40,000 to 60,000 lbs. may be obtained at each rear truck wheel.

The semi-monolithic brick pavements showed less resistance to impact than the monolithic brick pavements with same depth of concrete base (Bates Road.) The monolithic brick pavements showed about 18 % less resistance to impact than the plain concrete slab of equal depth. These results obtained by the Bureau of Public Roads on slabs 7 feet square.

The observed deflections of concrete pavements are very nearly directly proportional to the load (Pittsburg Test Road).

The resistance to structural failure of plain concrete pavement slabs of uniform thickness and laid on a uniform subgrade, when subjected to highway traffic loads, is in proportion to the square of the thickness of the slab (Bates Road Test).

Structural failure normally first appears at corners, caused by open cracks or joints. The edges of ordinary pavement slabs should be strengthened so that the corners and the edge of pavement may have approximately the same resistance to structural failure as the interior portion of slab.

The endurance limit of concrete when subjected to repeated tensile stresses may safely be taken as not less than 50 % of the modulus of rupture of the material (Bates Road Test).

The Committee on Economic Theory of Highway Improvement (Chairman, T. R. Agg, Iowa State College) reported that the following projects have been completed and results published or are in process of publication:

"Truck Performance on Grades" (Michigan Highway Commission and University of Michigan)

"Rolling Resistance and Related Characteristics of Roadway Surfaces" (Bureau of Public Roads, Iowa Highway Commission, Iowa Engineering Experiment Station)

"Economics of Highway Grades" (Iowa Engineering Experiment Station and Iowa State Highway Commission)

"Quartermaster Tractive Resistance of Roads Research."

Pavement Foundations

From paper presented at 29th Annual Convention of American Society for Municipal Improvement.

By Clarence D. Pollock
Consulting Engineer, New York City

The foundation is a very important part of a pavement and is a considerable item in both the first cost and in the maintenance of the pavement and should therefore receive the careful consideration which it deserves. The foundation should be sufficient to transmit the load on the pavement surface to the subgrade without material deformation and spread the load over a sufficient area of the soil so that its intensity does not exceed the safe bearing power of that soil. Too little attention has been paid to this portion of the pavement in the past, but with the much heavier loads of modern traffic more consideration is being given this matter. The Bureau of Public Roads has made and is now making tests to obtain more data in regard to the behavior of slabs under varying conditions of loading and impact and different conditions of sub-soil, and others have been working along similar lines, but there remains a great deal to be learned concerning this subject.

Foundation on Good Sub-Soil

An old macadam pavement has proved a good foundation in many cases when it was not necessary to make openings in it for sub-surface structures, but usually in city streets the most satisfactory foundation is one of portland cement concrete, commonly mixed in the proportion by volume of 1 part cement to 3 parts sand and 6 parts of broken stone or clean washed gravel. This foundation is generally laid either 5 or 6 in. in depth upon a well compacted sub-grade. Where the sub-soil is sand or sufficiently porous material to provide good drainage, these depths have proved sufficient even for present day traffic. For instance, in the Borough of Manhattan, New York city, with 6-in. depth of concrete foundations the chief engineer of highways stated at the Paving Conference in Philadelphia in October, 1921, that for a considerable period the cost of repairs due to foundation failures had been kept separately and at that time it amounted to less than one-tenth of 1% of the total cost of repairs per year. Any increase in depth of foundation here would surely be unnecessary and a waste of money. Some cities have had a tendency to lay heavier foundations, but with good sub-grade material it would seem to be expensive insurance. It is true that New York has generally good sub-soil conditions, but it is an ever changing city and probably has more construction openings made in its pavements per mile per year than any other city. There is frequent settlement of the sub-soil in these cities, but the concrete usually bridges over the moderate sized ones and carries the traffic. On Fifth avenue it was found that 6 in. of concrete foundation had bridged over a span of 6 ft. and had carried the traffic of that heavily travelled thoroughfare safely for years, although buses on that street when loaded weigh from 8 to 10 tons and carry from 6 to 10 tons on the rear axle.

Improvement of Sub-Grade

When the sub-soil is of clay or other material which cannot be readily drained, from the present progress of tests it would seem advisable to improve the subgrade rather than to weight it with a heavier foundation. In considering the bearing power of soils, a dry clay is usually capable of sustaining a load of 5 tons per sq. ft., but when very wet the same clay may not sustain more than 1 ton per sq. ft. By excavating a few inches additional and replacing with sandy or gravelly material the load will be spread so that with this and the better drainage a much greater load may be supported.

The foundation cannot act as a beam until the subsoil gives away sufficiently to allow it to act as such. The better the sub-soil the greater the load required to deform the foundation. The Washington tests show that with the sub-grade support the sustaining power of the concrete foundation varies more nearly as the square of the depth than directly as the depth.

Load Transmission by Sub-Grade

Measurements show that the foundation in transmitting the load to the sub-grade does not transmit it so that the pressure intensity is uniform. The pressure intensity is highest directly under the load, and spreads out over a considerable area, diminishing to nothing at some distance from the load. The intensity of pressure under the load must exceed the bearing value of the soil underneath before the foundation can act as a beam. Even a macadam, bituminous macadam or bituminous concrete foundation will not be deformed until the intensity of pressure directly under the load exceeds the bearing value of the sub-soil. If the load is stationary or if the surface of the pavement is very smooth there will be simply the static pressure, but if the surface of the pavement is a little rough there will be impact and if the surface is quite rough this impact may amount to four or five times the static pressure. This is greatest when the tires are badly worn; with good, well-cushioned tires the impact apparently approaches more nearly the static load, and hence the advisability of securing as uniformly smooth a surface to the pavement as possible in order that the impact of moving loads may be eliminated as completely as can be done

Tests by U. S. Bureau of Public Roads

In the Bureau of Public Roads tests with slabs on wet and dry soils, the impact tests punched through the 4-in. slabs, but those of 6 in. in depth and greater were simply cracked on up to those of 10 in. thick which could not be broken by their apparatus even on the wet sub-grades. According to this a thickness of 10 in. should be sufficiently great to carry any load that might come upon the pavement even with a wet subgrade which may be more or less plastic. However, we are not so likely to have wet sub-grades in city streets subject to heavy truck traffic as the pavement is usually impervious to water and likewise the sidewalks are generally paved so that there is much less liklihood of sub-soil troubles here than with suburban roads. But should there be bad sub-soil conditions, in general it will be found much less expensive to improve the subgrade than to pay for four extra inches of concrete in addition to the extra grade removal which alone would in most cases be sufficient when replaced by a more porous coarse-grained material which is not affected materially by water as are the very plastic soils such as many clays. With proper support from the subsoil and a reasonably smooth surface to the pavement, a thickness of 6 in. for the concrete foundation seems adequate, especially as most heavy loads are now hauled on auto-trucks having rubber tires. The trucking interests have found that it is not economical to carry loads in excess of about 750 lbs. per inch width of tires. This insures wide double and triangle solid rubber tires on each rear wheel and a good distribution of the load over the pavement so that by the time it is spread through the thickness of the pavement and the concrete foundation the pressure intensity is usually well within the supporting value of the soil. Some states have limited the loads permitted on their highways, but here we have a limit placed by the effect on the truck owners' pocketbook, which is more easily enforced than the other.

Supporting Power of Concrete Foundation

When in exceptional cases it may be necessary to use a greater depth of concrete than 6 in., it should be remembered that the supporting power of the concrete foundation varies about as the squares of the depths, as for example: 7-in. depth concrete would have about one and one-third the supporting power of 6-in. concrete; 8-in. concrete one and three-quarters; 9-in. concrete two and one-quarter, and 10-in. concrete three times nearly the supporting power of 6-in. concrete. By keeping this in mind it should prevent wasting money in using too great an increase in depth in special cases.

Another matter that the tests have brought out is the fact that while the compressive strength of 1:3:6 was 50% of that of the 1:1½:3 concrete the difference between the beam and slab strength of these two mixtures did not exceed 20%.

In addition to damage from heavy loads the pavement, including its foundation, may be injured by water entering a clayey or other plastic sub-grade material from terraces or sidewalks and lifting and cracking the foundation and pavement by the swelling of the sub-soil. Sometimes this may be caused by frost heaving the foundation when there is a large amount of water in the plastic soil under the foundation. During the past season the writer was engaged upon an examination of some breaks in foundation and pavement where a study of the conditions shown by openings and the history of the breaks as to when they were noticed after the completion of the pavements and before freezing weather and the soil condition in the terraces on the uphill side and the clay of the subsoil showed conclusively that the breaks were due to the soil conditions and not to any loads to which the pavement had been subjected. These are further reasons for improving the sub-soil rather than increasing the depth of the foundation, as a considerably heavier foundation would have probably been broken by the heaving of the clay when it became wet, and if not by this, then later by the action of the water in the subsoil freezing, and lifting the pavement.

About 20 years ago the author had several streets paved with asphalt on concrete foundation in a suburban development, where there was a layer of clay directly under the foundation and back of the curbs there were wide grass plots. A severe winter followed a wet fall and caused this pavement to be lifted as much as two inches in places as evidenced around sewer manhole heads. After the frost went out of the wet clay the pavement settled back, but unevenly, and cracked badly in so doing. Since that experience he has been very chary about placing the foundation directly on clay or other plastic material if there was any chance that water might penetrate it. Whether in a cold or in a warm climate as water alone will cause it to swell and lift the foundation and frost will increase its volume still more.

From our present knowledge we believe that a 6-in. depth of foundation is sufficient to carry modern traffic, provided the sub-soil is good, and if it is poor that it is better to improve the sub-soil rather than to use additional concrete in such cases.

Testing Materials for Concrete Pavements

Presented at 4th International Road Congress, Barcelona, Spain, 1923.

By Duff A. Abrams
Professor in Charge Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

The materials used in cement concrete pavements in the United States are as follows: (1) Portland cement, (2) Aggregates, (3) Water, and (4) Steel reinforcing wire or bars.

Tests of concrete materials are made for two distinct purposes: (a) To establish underlying principles, and (b) to determine whether a given sample conforms to certain predetermined standards. The two purposes in testing mark the distinction between *research* and *inspection*. The adequacy of the tests made in inspecting concrete materials is dependent upon the correctness of the principles established by research. In the following discussions only the standard tests for *quality of materials* will be included.

The American Society for Testing Materials has been engaged for many years in collecting data and preparing standard specifications and tests for all types of road materials. The Society is made up of representatives of both producers and users of materials. The tests of this Society are generally recognized as authoritative.

Tests of Portland Cement

Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum. Clinkering is produced in a rotary kiln at temperatures of about 1500° C.

The following tests are made on portland cement:

Fineness—using a sieve having 200 meshes per linear inch (79 per cm.)

Soundness—neat cement pat placed for 5 hr. over boiling water 24 hr. after mixing, must remain firm and hard and show no signs of distorting, cracking, checking or disintegrating.

Time of Setting—Vicat needle, initial set over 45 min.; final set less than 10 hr. Gillmore needle, initial set over 1 hr.; final less than 10 hr.

Tensile Strength—briquettes of 1 sq. in. cross-section of 1:3 standard sand mortar, by weight, must give a strength of 200 lb. (14.5 kg. per cm.) or over at 7 days, and 300 lb. (21.7 kg. per cm.) or over at 28 days, when stored 1 day in moist air and remainder in water.

Chemical Analysis—is only infrequently carried out.

General Requirements for Aggregates for Concrete Pavements

Aggregate is defined as "Inert material which is mixed with portland cement and water to produce concrete; in general, aggregate consists of sand, pebbles, crushed stone, blast-furnace slag, or similar materials."

Aggregate for concrete pavements must be clean, structurally sound and inert in the presence of cement and water; it must possess also a certain quality which we may term weather-resistance. The separation of aggregate into fine and coarse is generally required since it facilitates securing uniformity in the grading of successive batches. A wide variety in size and grading may be used with good results.

Tests of aggregates have been undergoing marked changes during the past few years. The earliest tests of coarse aggregates were adapted directly from those made on rocks for macadam roads. Experience has shown that the tests for hardness, toughness and cementation values which were formerly made on crushed rocks for macadam road construction are of little use in judging the quality of an aggregate for concrete pavements.

TESTS OF FINE AGGREGATE

Fine aggregates are generally subjected to the following tests:

Sieve Analysis—Use wire cloth sieves having 100, 50, 30, 16, 8 and 4 meshes per linear inch.

Organic Impurities in Sand—Digest sample in 3% solution of sodium hydroxide and observe color after 24 hours.

Silt—Determine loss of weight of 500-gram sample, due to washing in shallow pan and rejecting wash water.

Mortar Strength—Tension tests of briquettes or compression tests of 2- x 4-in. mortar cylinders at ages of 7 and 28 days, using 1:3 mix by *weight* or by *volume*. Make parallel tests on 1:3 standard sand mortar. There is a growing tendency to substitute compression tests of mortar for tension tests in tests of both sands and cements.

TESTS OF COARSE AGGREGATE

Coarse Aggregates are generally subjected to the following tests:

Sieve Analysis—Use square-mesh wire-cloth sieves No. 4 (that is, 4 meshes per linear inch), $\frac{3}{8}$ in., $\frac{3}{4}$ in. and $1\frac{1}{2}$ in.

Abrasion—Determine percent of wear in Deval abrasion machine, using 50 pieces of crushed rock weighing 5000 grams and run for 10,000 revolutions at 30 r.p.m. A number of modifications of this test have been introduced during the past few years, in an effort to make the test more applicable to the requirements of graded sizes of crushed rock or gravel.

MISCELLANEOUS TESTS OF AGGREGATE

In addition to the foregoing tests which are more or less standard, the following tests are sometimes made on aggregates:

Unit Weight—Puddle a sample in a metal measure of cylindrical form with depth equal to diameter and of $\frac{1}{10}$ to 1 cubic foot capacity, using a small metal bar and filling the measure in three equal layers. The weight is reported in pounds per cubic foot.

Toughness of Gravel.—The U. S. Bureau of Public Roads has recently introduced an impact test for gravel which is expected to reveal the presence of soft or friable particles. It is made by dropping a steel ball of known weight on a selected number of particles from the sample. The height of drop required to produce rupture is a measure of the toughness of the gravel.

Shale in Gravel—Separate shale by flotation process, using a solution of zinc sulfate.

Concrete Strength—In many instances the quality of both fine and coarse aggregate is determined by 28-day compression tests of 6- x 12-in. concrete cylinders of the mixture to be used on the work. In making concrete tests, care must be used to procure a uniform consistency in the various mixtures. Concrete for these tests is generally mixed by hand.

Wear Tests of Concrete—Considerable experimental work has been done in laboratory studies of the wearing resistance of concrete. A number of different types of apparatus have been developed for this purpose.

SAMPLES OF AGGREGATES

Laboratory tests of aggregate require about 25 lbs. of fine aggregate and about 50 lbs. of coarse aggregate. If concrete tests are to be made, larger samples will be necessary. Great care is necessary to secure representative samples.

FIELD TESTS OF AGGREGATE

Many of the Highway Departments supply inspectors with apparatus for making approximate field tests for silt, organic impurities, sieve analysis, etc., as the aggregate is delivered on the work.

RELATIVE MERITS OF DIFFERENT AGGREGATES

Many different types of aggregates may be used for concrete pavements. There is a growing recognition in the United States of the fact that the quality of the *concrete* is more important than the quality of the aggregate, and that with proper care in proportioning, mixing, placing and curing, concrete of high quality can be produced with inferior aggregate.

WATER

In general no special tests are made on the water used in mixing concrete. Specifications for concrete require that water shall be clean and free from oil, alkali, organic matter or other deleterious substances. Only in rare instances is difficulty encountered in securing water of good quality.

TESTS OF REINFORCING STEEL

The following tests are made on reinforcing bars or wires: (a) Tensile strength, (b) Elongation, (c) Reduction in area, (d) Chemical analysis.

LABORATORIES FOR TESTS OF CONCRETE MATERIALS

There are approximately 100 laboratories in the United States which are equipped to carry out tests of cement, aggregates, etc. These may be classified as follows:

(1) U. S. Government
    (Bureau of Public Roads, Bureau of Standards, etc.)
(2) State Highway Departments
(3) County and Municipal
(4) Universities and Schools
(5) Private Testing Laboratories
(6) Railroads and Miscellaneous

BIBLIOGRAPHY

For specifications and standard methods of tests and results of research work on portland cement, aggregates, concrete and reinforcing steel, see "Standards," 1921, American Society for Testing Materials, Philadelphia, Pa.

Many reports on tests of cement, aggregate and concrete are published in:

(1) Proc. American Concrete Institute, Detroit, Mich.
(2) Engineering News-Record, (Weekly) New York, N. Y.
(3) Public Roads (Monthly) U. S. Bureau of Public Roads, Washington, D. C.

For abrasion tests of crushed stone, slag and gravel by different methods, see "Selection of Aggregates for Concrete Roads," by Duff A. Abrams, Proc. American Road Builders' Assn., 1922.

Road Subgrade

Recommendations of the Committee on Structural Design of Highways (A. T. Goldbeck, U. S. Bureau of Public Roads, Chairman) of the Advisory Board on Highway Research, are summarized as far as they have to do with subgrade, as follows:

A layer of sand, cinders, broken stone, or other porous material will prevent capillary moisture from rising to the overlying road surface. Tile drains are inefficient in removing capillary moisture.

Results of tensile, shear, and compression strength tests on various soils are given in detail in the report.

A "Field Test for Moisture Equivalent" described in detail in the report gives a tentative criterion for classifying soils as to their suitability for use as a subgrade.

The addition of 5 % of hydrated lime or portland cement, to a soil materially reduces the expansion and contraction of the soil. The admixture of sand with the soil has a similar effect.

Heat treatment of the soil requires a temperature of 600° C. to affect a physical change in the soil. At this temperature the clay content is reduced and the sand content increased, resulting in a reduction of the expansion and contraction of the soil.

Drainage ditches are effective only in removing water in excess of the capillary moisture.

There is every evidence to show that temperature has a very marked influence on the water capacity of soils. The colder the soils the greater the capacity for holding moisture.

Some materials, such as many types of clay, take up considerable quantities of moisture when it is available and expand in volume, while other materials like sand, gravel, crushed slag, etc., take up only enough moisture to coat the surfaces of the particles and show little expansion.

When macadam or broken stone bases are used over a heavy clay subgrade it often happens that the clay is forced up through the voids in the stone and renders the broken stone layer much less resistant to loads. A light blanket of sand or similar material interposed between the subgrade and the broken stone is effective in preventing the clay from working up through the overlying stone layer.

The soil itself does not expand on freezing, but the expansion occurs in the moisture alone.

Cost Keeping for Concrete Products Plants

From an address by William J. Rathke, Secretary, Seyberth-Neuser Co., Eau Claire, Wisc., at the recent convention of the Wisconsin Concrete Products Assoc.

I should like to head my talk "Bookkeeping" instead of "Cost Keeping," as, without first getting the transactions of your business in their proper sequence in books of record, no satisfactory costs can be ascertained.

In working throughout my locality, and I believe that it is typical of all parts of the country, I find that men engaged in the smaller trading and manufacturing lines, especially where owned individually, do not keep their records in an orderly way. Then, when income tax time comes round, a mad scramble occurs to locate the information required by the Government.

Would it not be a much better plan to keep a simple set of books in which to record systematically all of the transactions of your plant, at the same time accumulating the figures the Government requires, and also get some facts on what it costs you to run your business during the year? An analysis of these figures at the end of the year, in a way which I will explain later, will enable you to find out what each item of expense is per block made.

I know one man in the products business who figures his income as being his balance in the bank at the end of the year, added to the value of the blocks still on hand. This is a dangerous practice, and will eventually lead to insolvency. He is taking no account of wear and tear of machinery, neither is he deducting bills owing at the end of the year. In five or ten years when new machinery is to be bought to replace the old, where is the money coming from to buy it? A satisfactory figure of depreciation must be charged against your expense each year, in order to be able to carry on your business indefinitely. This matter of depreciation in the products business demands serious consideration, as we know from experience that few industries are as hard on their machinery and equipment as is this one.

We have devised a simple system of bookkeeping especially for concrete products plants. You can use it as it is, or it can be changed to suit your own requirements. It does not make any difference what you do, but the point I want to impress is to keep a good system of some kind to record the happenings of your plant, so that you can know very easily the cost of your products. The time of large profits is gone, and you are many times required to shave prices in order to get a job. Unless you know your costs, you can very easily be induced to part with your goods for less than cost of manufacture.

The thought was to get all of your records under one cover, with the exception of a ledger, a system similar in part with those on the market today, used by retail stores.

A sales record is provided to record credit sales as they occur. From here the amounts will be transferred, or posted, as we say, to the customers' account in the ledger. The total of this record will each month be posted to the credit of sales.

A cash record is provided to record all cash received on account, for cash sales of products, and any other cash which might be received. Credits to customers will, of course, be posted to their account in the ledger, and sales would receive credit for cash sales..

On the other side you have a large record in which to enter all money paid out, whether in the form of checks or cash, with many columns showing most of the important items of expense. These special columns are posted in total at the end of the month after first balancing the page, and the items at the extreme right of the page are posted individually to the ledger.

These forms provide for the actual disbursement of cash. All during the year, however, you are having a certain wear and tear of all the machinery and equipment in your plant. It is necessary, at the end of each year, to credit a reserve for depreciation to cover this wearing away of your assets. And, gentlemen, do not forget to make this reserve large enough. Ordinarily, machinery used in this business will not last more than five years. Therefore, 20% of the original cost will go into this reserve account each year. A reserve will also have to be set up for wearing out of equipment, such as trucks, shafting, boilers, pallets, etc. Also motor trucks, if you deliver your own product, will depreciate to the extent of 33⅓% a year.

I have written up a list of accounts which are thought necessary for a products business. Some of you possibly are following closely to this procedure now. The main thing in making up your list of account is not to crowd expenses, which are not related, in one account called plant expense. One cannot easily ascertain cost of power, fuel, repairs, etc., from a lumped amount running into four figures.

We have also devised a simple plan of costing the products manufactured daily. We do not claim to follow accepted accounting standards, but are trying to give you an easy means of determining the cost of each block made. A proper care in fixing the item of overhead expense will, together with the labor, cement, and aggregate cost, give you a very close cost of all blocks manufactured and put in the yard.

A line is provided showing the number of sacks of cement used, with total cost of cement used that day. In case you purchase your aggregate, the cost at the factory is used, and the amount extended covering cost of yards used that day. It is easy to determine the yardage by weighing the contents of a one-bag mix and multiplying at the end of the day by the total number of bags cement used. The direct plant labor is listed, so that the report also will act as a time card. I might add here that in case more than one machine is in operation, one report should be made for each machine to better watch production of crews. In this case the overhead will be divided equally between the machines when they are in operation.

If a machine is later discontinued, do not lose sight of the fact that the machine, or machines, still remaining must carry all of the overhead. Also the machine, or machines, still remaining must carry all of the direct labor of the plant.

I will illustrate this overhead item. It is necessary to collect all of the plant expense for the year. Those of you who have been operating for several years should collect the figures for at least three years, and get an average expense of the plant for one year. In case you do not have any record of past expenses, estimates should be made.

After you have found the total of overhead in your plant for the year, including taxes, insurance, and depreciation, as illustrated, this amount is divided by the number of days in operation. Obviously there is no money made when the machinery is idle. Therefore, the overhead for the whole year is chargeable on the cost sheets for that part of the year that blocks are made. Some of you work 300 days and some only 100 days. For purpose of illustration I have used

200 days of operation.

This figure of overhead is then put down on the daily plant report regardless of how many units are turned out each day. Some days the full run is impossible, due to breakdowns and other reasons, and the cost per unit will run up very high. However, these daily sheets should be summarized at the end of each month, and a really close figure of cost is determined.

I might here illustrate a method of analyzing your annual operating statement showing the cost per unit of each class of expense. These figures are not actual, but will serve to show the results of a year's operations based on 150,000 12-in. blocks. This will compare with 75,000 of 24-in. blocks and 100,000 of 16-in. blocks. Here each item of expense is shown in total for the year, and also on the basis of cost per unit.

It is much better to reduce your expenses for the year to a basis of cost per block. By this method you will be able to determine the items of expense which are eating up your profits and govern your future policy accordingly.

In case you do not now have a bookkeeper and cannot do this work yourself, I would suggest having a bookkeeper on a part-time basis, as a great many companies are now doing. The cost will run from $15 per month upward, according to the volume of your business. It is possible, in this way, to get a higher class of work done at small expense. Start a good set of records, and watch your expense items carefully. All of the net profit in this business is not made on the outside.

ANALYSIS OF COSTS
PER YEAR

Figures Based on Sales of 150,000 Twelve Inch Units.

				Per Unit
Block Sales		$17,785.50		$11.85
Gravel Sales		414.84		
Total Sales			$18,200.34	
Inventory Beginning	$1453.59			
Cement Purchases	6063.44			
	$8517.03			
Inventory End of Year	2083.89			
Material Cost		$ 5433.14		3.62
Direct Cost				
Plant Labor	$2843.84			1.90
Truck Driver & Yard Help	974.42			.65
Power and Light	350.36			.23
Gas, Oil and Grease	463.59			.31
Repairs Machinery	171.84			.11
Repairs Equipment	40.72			.02
Fuel	77.55			.05
Truck Repairs	886.16			.59
Insurance	167.23			.11
Misc. Plant Expense	25.77			.02
Total Direct Cost		$ 6001.48		$3.99
Indirect Cost				
Taxes	$ 330.43			.22
Depreciation	1937.67			1.29
Total Indirect Cost		$ 2268.10		$1.51
Selling Expense				
Advertising	$ 311.95			.21
Traveling Expense	139.41			.09
				$0.30
Total Selling		$ 451.36		
Administration				
Manager Salary	$1800.00			1.20
Office Supplies	29.75			.02
Telephone	32.69			.02
Total Administration		$ 1862.44		$1.24
General				
Interest Paid	$ 617.98			.41
Misc. General Expense	59.18			.05
Total General		$ 677.16		.46
TOTAL COST			$16,693.68	$11.12
NET PROFIT			$ 1,506.66	

ANALYSIS OF OVERHEAD
Days Worked—200

Salary Manager	$1800.00
Power and Light	350.36
Gas, Oil and Grease	463.59
Repairs Machinery	171.84
Repairs Equipment	40.72
Fuel	77.55
Misc. Plant Expense	25.77
Truck Repairs	886.16
Insurance	167.23
Taxes	330.43
Depreciation	1937.67
TOTAL	$6251.32

Method of Figuring Depreciation.

	Cost	Rate	Amt. Dep.
Building	$4302.97	3%	129.09
Block Machine	3912.68	10%	391.27
Equipment	1597.71	10%	159.77
Truck	2414.00	25%	603.25
Gravel Bins & Equipment	2577.59	15%	406.64
Tractor	990.60	25%	247.65
			$1937.67

Total overhead for year		$6251.32
Number days worked	200/6251.32	
Overhead per day	$31.26	

The Profits From An Improved Road

A thesis by J. L. Thayer, engineer, Lincoln county, Washington, in which the author discusses the development of a highway system in a semi-arid and sparsely settled farming community is discussed by *Engineering and Contracting*.

In the case of one 11-mile improvement, the little community of Peach was called upon to bear 25 % of the total assessment. On the high grade orchard land the assessment was $50 per acre, and it may be imagined that it was not easy to secure the approval either of the farmers of Peach or of the owners of less valuable lands along the route. Sufficient support, however, was gained, and in the year 1922—the first following the completion of the road—the residents of Peach saved in costs of fruit hauling alone about one-third of their entire assessment. In addition to this there were other real, though less easily measured, financial savings, and all the added benefits of comfort, convenience and pleasure. We quote from Mr. Thayer's thesis:

"The argument that highways are needed for social, religious or pleasure purposes is not so convincing as the argument that highways are a good investment from a purely monetary standpoint. For instance, in Lincoln county, that highway known as Donohue Road No. 3, beginning at the town of Creston and extending 11 miles northeast to the town of Peach on the Columbia river, was constructed under an assessment plan, and the people of Peach owning 300 acres of irrigated orchard tracts were assessed for this improvement $15,000, or $50 an acre. The annual production of fruit at Peach is 84,500 boxes of apples, 42,500 boxes of pears, and 50,000 boxes of peaches. The owners of this fruit hire it hauled by truck to Creston. The road was completed in 1921, and in the fall of 1922 hauling the peaches cost 3¢ to 4¢ each box less than it had cost in 1921. Hauling apples and pears cost 3¢ to 5¢ each box less. A simple problem in arithmetic will prove then that the actual saving to the people of Peach each year is approximately $6,000 in the handling of their fruit alone; therefore, for the people of Peach the road will pay for itself in less than three years. Assuming that instead of 25% of the cost, they had paid 100% of the cost, the road would pay for itself in 12 years."

This example is pertinent. It is not sufficient that the ignorant and unreasoned opposition of a generation ago have been largely overcome: it is still necessary, as it should be, to convince taxpayers that they will receive suitable returns upon their assessments. Examples like that of Peach show what can be done in some cases. Show a man an investment yielding 33⅓ % or half that much, and hard up though he may be, he will generally find a way to raise the money.

The public grows more canny, and mere loud boosting becomes decreasingly effective. Its object may or may not be worthy. But add careful study and analysis to honest boosting and a really good project can generally be carried.

Placing Concrete in Grandstands and Stadia

Important Items for Specifications With Cost Data

Courtesy Portland Cement Association, Chicago, Ill.

Reinforced concrete grandstands are structures which necessarily have a large exposed area in proportion to the volume of concrete. For this reason, there is need for a method of control during construction that will assure a good quality of concrete. The inspector must not permit an excess of water to be used, he must see that the ingredients of the concrete are not allowed to become segregated, and he must insist that the concrete be kept moist for at least one week after it is deposited.

Concrete mixed with an excess of water has low strength, low resistance to abrasion and high absorption; yet the same materials, if mixed with the proper quantity of water, will produce a concrete that is entirely satisfactory in strength and durability. Only enough water should be used to produce a workable mixture. The so-called sloppy mixture *must* be avoided.

In chuting concrete, the chute should be sloped not less than 35° with the horizontal, so that the concrete will slide along the trough without the use of too much water. The concrete should not be deposited directly from the chute into the forms, unless the operation is continuous. When the operation is intermittent, the chute should discharge into a hopper. In either case, the concrete should be deposited in its final position within 30 minutes after it is mixed.

The concrete must be kept moist during the first week after it is deposited. Experiments made at the Structural Materials Research Laboratory of the Lewis Institute, Chicago, show that concrete protected from loss of water by evaporation during the first 10 days after being placed will develop a strength and resistance to abrasion at least 50% higher than if the concrete were permitted to dry prematurely. In the construction of a reinforced concrete grandstand at Huron, S. D., in 1918, the forms were left in place while the concrete was hardening and were sprinkled repeatedly for one week.

Engineers have commonly considered that a 1:2:4 mixture of concrete will develop a strength of 2,000 lb. per sq. in. in 28 days, and this strength can easily be reached if the work is subjected to intelligent inspection and supervision. The cost of such inspection and supervision is very small price to pay for the additional strength and durability obtained.

Water of a proper quality must be used. Strongly alkaline water should be avoided, and owing to the possibility that marsh waters may contain sufficient humus matter to affect seriously the strength of concrete, they should be looked upon with suspicion until tested in concrete and found satisfactory. A safe specification is to require that the mixing water shall be potable.

The substance of the foregoing should be incorporated in specifications governing the construction of grandstands and stadia.

COST DATA ON CONCRETE GRANDSTANDS AND STADIA

Cost data on grandstands and stadia necessarily show a wide divergence in cost per seat, because of the varying conditions and the great variation in the facilities to be provided. While a small grandstand, built for several hundred people, might consist of very little besides the actual structure, the great concrete stadium in Seattle, built for the University of Washington, includes a number of special features, such as dressing rooms, shower baths, lockers, toilet rooms, four public comfort stations, office space, six ticket offices, and an information booth, a covered entrance with six ticket stalls, six exit gates and an iron fence around the stadium. In large cities, if the space is limited, construction work has to be carried out under difficulties and the unit cost is sure to be higher than in locations where there is sufficient "elbow room." On the other hand, in instances where advantage can be taken of the natural contour of the ground, as in a ravine or narrow valley, excavation is greatly reduced and the cost will be considerably below the average.

Before the war, structures of this kind cost around $4 to $7 per seat. The Seattle stadium, previously mentioned, was built in 1920 at the peak of construction costs at a unit cost of $10.58 per seat. On that work cement workers were paid $9.00 per day and common laborers were paid $5.00. Note also that the cost per seat of the University of Pennsylvania Stadium, built in 1922, was only 37% higher than the unit cost of Harvard Stadium, built in 1903, even though general construction costs had increased far more than that amount. This is due entirely to the improved organization and construction methods now being applied to reinforced concrete construction.

Following are some cost data on a variety of structures built at various times:

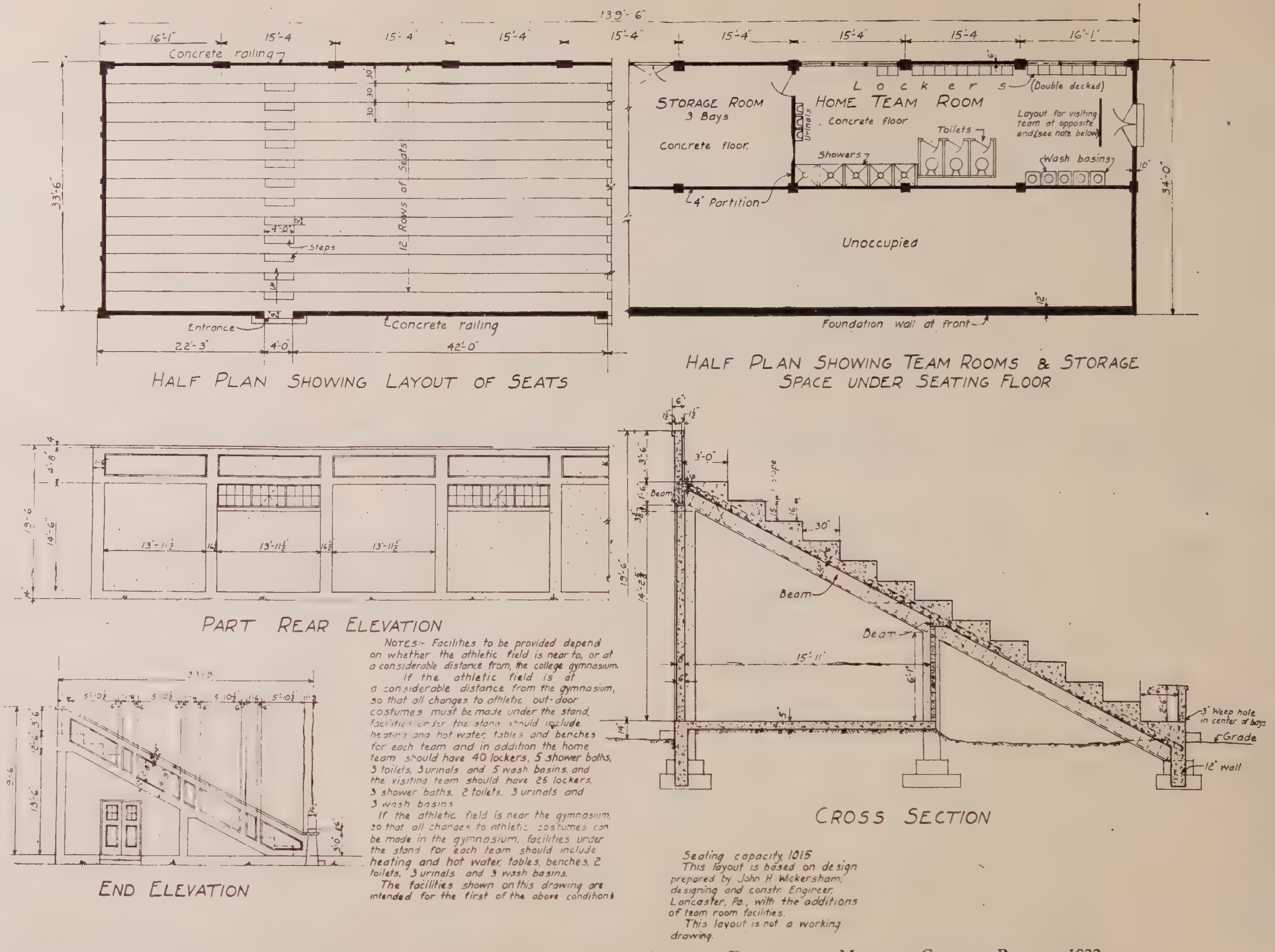
1. Harvard Stadium, the pioneer among concrete structures of its kind, was built in 1903, with a few special features added in 1909. Capacity is 40,000. Cost, including features added in 1909, was $425,000, or $10.60 per seat. *Engineering Record*, Dec. 12, 1903, page 733, contains an illustrated description of construction methods.

2. Reinforced concrete stadium for University of Pennsylvania, Philadelphia, capacity 50,000. Contract awarded May 1, 1922, to the Turner Construction Co., New York City. The contract price of $725,000 ($14.50 per seat) was based on an alternate design in reinforced concrete, and was $30,000 lower than the lowest bid for a fireproof structural steel frame.

3. Grant Park Municipal Stadium, Chicago, Ill., capacity 100,000. Under construction in 1923. Contract price about $2,500,000 or $25.00 per seat. Reinforced construction throughout. Concrete cast stone used for exterior face and exterior trimstone. For complete description see *Engineering News-Record*, Feb. 15, 1923, pages 288-291.

4. Illinois University Stadium, Urbana, Ill., capacity 60,000. Under construction in 1923. Cost $1,603,500, or $26.75 per seat. Partly reinforced concrete and partly of structural steel. Excellent architectural features. For complete description, details and illustrations, see *Engineering News-Record*, Jan. 18, 1923, pages 102-105.

5. Reinforced concrete tennis stadium on the grounds of the West Side Tennis Club, Forest Hills, Long Island, N. Y. Construction was started April 9, 1923. Stadium shaped like horse-shoe, inclosing three courts. Seating capacity 13,000; cost $150,000, or



NOTES:- Facilities to be provided depend on whether the athletic field is near to, or at a considerable distance from, the college gymnasium.

If the athletic field is at a considerable distance from the gymnasium, so that all changes to athletic out-door costumes must be made under the stand, facilities under the stand should include heating and hot water, tables and benches for each team and in addition the home team should have 40 lockers, 5 shower baths, 3 toilets, 3 urinals and 5 wash basins, and the visiting team should have 25 lockers, 3 shower baths, 2 toilets, 3 urinals and 3 wash basins.

If the athletic field is near the gymnasium, so that all changes to athletic costumes can be made in the gymnasium, facilities under the stand for each team should include heating and hot water, tables, benches, 2 toilets, 3 urinals and 3 wash basins.

The facilities shown on this drawing are intended for the first of the above conditions

Seating capacity 1015

This layout is based on design prepared by John H Wickersham, designing and constr. Engineer, Lancaster, Pa., with the additions of team room facilities.

This layout is not a working drawing.

FIG. 1—SUGGESTED DESIGN FOR CONCRETE GRANDSTAND TAKEN FROM THE DESIGN OF STAND FOR FRANKLIN AND MARSHALL COLLEGE, BUILT IN 1922

about $11.50 per seat. Will require 4,500 bbl. of cement and 170 tons of reinforcing steel. Designer, Charles S. Landers, Consulting Engineer, New York City. Architectural features by Kenneth M. Murchison, Architect, 101 Park Ave., New York City. Contractor, The Foundation Co., New York City. Illustrated in the *New York Times*, April 15, 1923.

6. Reinforced concrete grandstand at Tampa, Fla. Capacity 4,000. Contract awarded to Logan Bros. in Feb. 1923 at $30,000, or $7.50 per seat.

7. Stadium for Ohio State University, Columbus, Ohio. Capacity 63,000. Partly of reinforced concrete and partly of structural steel. Joseph N. Bradford, Architect; Howard D. Smith, designer; Wm. S. Hindman, Structural Engineer, all of the University faculty. Contract let to E. H. Latham & Co. at $1,341,000 or $21.30 per seat. Completed in 1922. See *Engineering News-Record*, Oct. 19, 1922, for a 5-page illustrated article describing design and construction in great detail.

8. Reinforced concrete grandstand in Christopher Gibson Playground, Boston, Mass. Designed and built in 1922 by the Boston Park Department. Seating capacity 2,100, length 276 ft., width 10 rows of seats. Quantity of concrete, 658 cu. yd. Cost $19,841, equal to $9.45 per seat or $30.15 per cu. yd. of concrete. Expansion joints every 40 ft., filled with an asphalt preparation.

9. "Test of a Gunite Grandstand Seat" is the title of an article in *Engineering and Contracting* (Chicago), July 26, 1922, page 85. Illustrated with a half-tone view and design details of a test slab made by the Cement Gun Construction Co., Chicago. Withstood live load of 300 lb. per sq. ft. without breaking.

10. Reinforced concrete stadium for the University of Kansas, Lawrence, Kans. Seating capacity when fully completed will be 32,000. Seating capacity of part now completed is 15,500. Cost of completed portion and of improvements to entire playing field $235,000 or $15.15 per seat. Designed by C. C. Williams, F. L. Brown, Laforce Bailey and L. H. Dodd, of the University faculty. Contract awarded July 9, 1921, to the Unit Construction Co., Title Guaranty Building, St. Louis, Mo. Fully described and illustrated in *Engineering News-Record*, Nov. 9, 1922.

11. Reinforced concrete grandstand for Franklin and Marshall College, capacity 1,015, built in 1922. See Fig. 1 and cost data elsewhere in this article.

12. Concrete stadium for the University of Washington at Seattle. Built in 1920; seating capacity 40,000. Architects, Bebb and Gould, Seattle; Consulting Engineer, Henry Bittman, Seattle; Contractors, Puget Sound Bridge and Dredging Co., Seattle. Contract price complete was $423,000 or $10.58 per seat. This stadium was built at the peak of construction costs, cement workers having been paid $9.00 a day and common laborers $5.00. The June, 1921 issue of CONCRETE (Detroit) contains a complete description of construction methods. Excavation was accomplished by sluicing, embankments were made by hydraulic filling, and molds for concrete steps were formed by the shear-board method. *Engineering News-Record*, July 6, 1922, page 11, reports that no defects of any kind had developed after 18 months of service.

13. Reinforced concrete grandstand at Huron, S. D., built in 1918. Capacity 5,500. Cost $55,000. See Fig. 2 and description of construction methods elsewhere in this article.

14. Reinforced concrete grandstand for Lucas County Agricultural Society, Toledo, Ohio. Built in 1918. Capacity 3,000. Designed by M. M. Stophlet, 608 Nasby Building, Toledo. Portland Cement Association has blue prints available. Cost $45,000 or $15.00 per seat.

15. Reinforced concrete grandstand, State Normal School, Whitewater, Wis. Built in 1915. Seating capacity 800. Architects, Van Ryn and DeGalleke, Milwaukee, Wis. Contractor W. T. Kiernan Co., Whitewater. Contract price was $4,248, or $5.31 per seat. See description, including details and half-tone view, in *Cement Era*, January, 1915.

16. Stadium at Balboa Park, San Diego, Calif. Built in 1915, seating capacity 30,000. Architects, Quayle Brothers and Cressy, San Diego. Contract price was slightly under the municipal bond issue of $150,000. Cost $5.00 per seat.

17. Reinforced concrete stadium, Cornell University, Ithaca, N. Y. Completed in 1915. Capacity 8,640. Dimensions, 600 ft. long and 75 ft. wide. Contract price $64,251, or $7.44 per seat, or $1.43 per sq. ft. of area. Architects, Gibb & Waltz, Ithaca. Contractor, Driscoll Brothers & Co., Ithaca.

18. Concrete stadium for University of Michigan, Ann Arbor, Mich. Built in 1914. Seating capacity 13,200. Built entirely of reinforced concrete, 429 ft. long and 121 ft. wide. Concrete columns are set in rows 16 x 22 ft. apart, cross-braced with concrete struts. There are 55 rows of seats with aisles every 30 ft. The reinforced concrete deck is stepped for seats. The structure has no roof. Cost $55,000, or $4.17 per seat. H. J. Weeks, Detroit, Mich., was the designer and contractor. Article in *Cement World*, July 1914, contains illustrations and details of design.

19. Palmer Memorial Stadium, Princeton University. Built in 1914. Seating capacity 41,000. Architect, J. H. Hardenburgh, New York City. Engineers, Purdy and Henderson, New York City, Contractor, George A. Fuller Co., New York City. Contract price was $300,000 or $7.32 per seat.

20. Yale Bowl, New Haven, Conn. Built in 1913. Seating capacity, 61,000. Cost $400,000 or $4.92 per seat.

21. High school stadium, Tacoma, Wash. Built in 1909. Seating capacity, 30,000. Cost $175,000 or $5.84 per seat.

22. Concrete stadium for Syracuse University, Syracuse, N. Y. Normal seating capacity 20,000. Can be increased to 40,000. 475 ft. wide and 670 ft. long, oval in shape. Built entirely of reinforced concrete, largely on earth slopes. Designed by Profs. Revels and Hallenbeck of Syracuse University and built by Consolidated Engineering and Construction Co. Fully described and illustrated in *Architect and Builder*, April, 1908.

23. Reinforced concrete amphitheater, University of California, Berkeley, Calif., seating capacity 8,000. Greek style, circular form. Seats of reinforced concrete built on earth slope in natural depression in hill side. Cost $42,000 or $5.25 per seat. Contractors, Langren & Hicks, Berkeley, Calif. See article in *Engineering Record*, December 31, 1904.

24. Los Angeles Stadium, under construction in 1923, to be completed early in 1924. Capacity 75,000. Cost about $1,000,000, or $13.33 per seat. Later addition of a gallery will increase capacity to nearly 125,000. Located in Exposition Park. Architects, John and Donald B. Parkinson, Los Angeles. Owners, Community Development Association, a non-profit organization. Described and illustrated in *Scientific American*, May, 1923, page 321.

25. Reinforced concrete grandstand for the Orange County Agricultural Society, Port Jarvis, N. Y. Capacity 2,000. Contract awarded to M. J. Cleary, Middletown, N. Y., in May, 1923, at $30,844, or $15.42 per seat.

26. Reinforced concrete stadium for the University of Indiana, contract reported on page 197 of Aug. 2 (1923) issue of *Engineering News-Record* as having been awarded to the Bedford Construction Co., Bedford, Ind. Capacity of part contracted is 22,000. Ultimate capacity will be 50,000. Contract price for the 22,000 seats is $4 per seat for the structure alone, not including grading, plumbing, heating, lighting, drainage or incidentals. The cost per seat, excluding only grading, will be about $6.

27. University of California Memorial Stadium, seating capacity 72,800. Contract awarded May 15, 1923 at a little over $1,000,000, or about $13 per seat. Area of actual structure totals 250,000 sq. ft., 62% of which rests directly on the earth slope, and 38% is supported on reinforced concrete girders and columns. Description and construction views in *The Architect and Engineer* (San Francisco), October, 1923, pages 93-98 and CONCRETE, Detroit, April, 1924.

SUGGESTED DESIGN FOR CONCRETE GRANDSTAND WITH UNIT COSTS AND MATERIAL QUANTITIES

The following data pertain to the reinforced concrete grandstand showin in Fig. 1. The drawing is based on the grandstand for Franklin and Marshall College, designed by John H. Wickersham, of Lancaster, Pa., and built in 1922. This is a deck type, without a roof. The unit cost and material quantity figures determined below should consequently be applied only to stands of a similar type. The unit figures will give designing engineers and city or school officials a sufficiently close approximation for preliminary cost and quantity estimates for larger or smaller stands of the deck type.

Ground area of structure, 4,743 sq. ft.		
Concrete Mixtures: 1:2½:5 in footings, 1:2:4 in seat deck, walls, floor, parapets and partitions, and 1:1½:3 in columns.		
Concrete, classified:		
1:2½:5 concrete in footings		22 cu. yd.
1:2:4 concrete:		
In floor	35	
In partitions (May be of block)	12	
All other 1:2:4	333	
		380 cu. yd.
1:1½:3 concrete in columns		23 cu. yd.
Total concrete		425 cu. yd.
Reinforcing steel		26,200 lbs.
Approximate cement quantity		670 bbls.
Estimate, based on cost of similar structure built in Boston in 1922		$12,000
Capacity, based on 18 in. per person		1,015
Unit costs and quantities:		
Concrete per sq. ft. of ground area, 0.0895 cu. yd. or 2.42 cu. ft.		
Steel reinforcement per sq. ft. of ground area, 5.5 lb.		
Concrete per seat		0.42 cu. yd.
Reinforcing steel per seat		26.0 lb.
Area per seat		4.67 sq. ft.
Estimated cost per seat		$11.90
Estimated cost per cu. yd. of concrete		$28.50
Estimated cost per bbl. of cement		$18.10

REINFORCED CONCRETE GRANDSTAND AT HURON, S. D.

Fig. 2 shows the South Dakota State Fair Association's reinforced concrete grandstand at Huron, S. D., completed in 1918 to replace an old wooden structure. It has a seating capacity of 5,500, and cost $55,000, or $10.00 per seat. It was designed by Homer M.

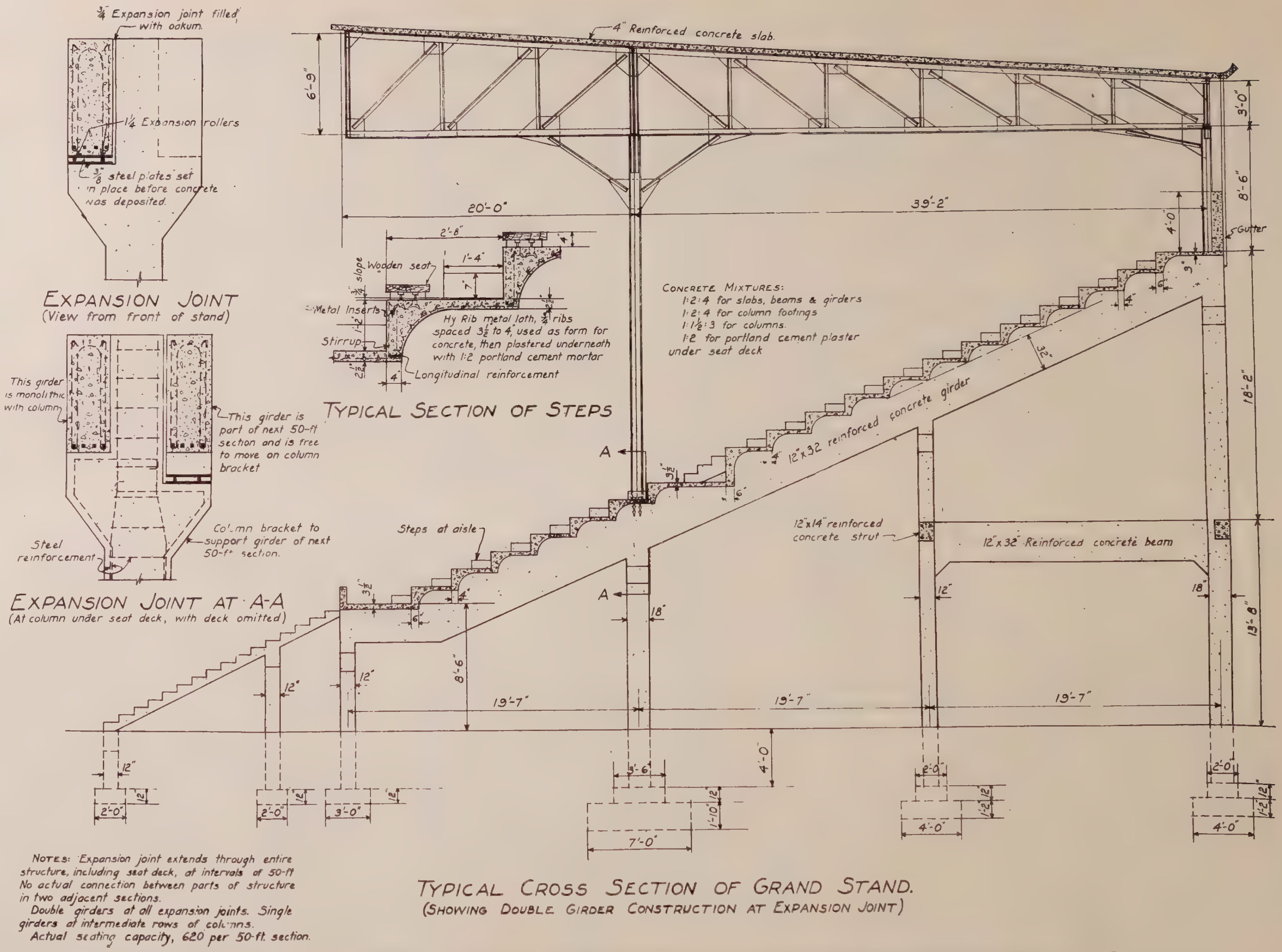

¾" Expansion joint filled with oakum.
1¼ Expansion rollers
⅜" steel plates set in place before concrete was deposited.
EXPANSION JOINT
(View from front of stand)
This girder is monolithic with column
This girder is part of next 50-ft section and is free to move on column bracket
Column bracket to support girder of next 50-ft section.
Steel reinforcement
EXPANSION JOINT AT A-A
(At column under seat deck, with deck omitted)
4" Reinforced concrete slab.
6'-9"
3'-0"
8'-6"
Gutter
20'-0"
39'-2"
4'-0"
2'-8"
1'-4"
Wooden seat
slope
Metal Inserts
Stirrup
Hy Rib metal lath, ⅜" ribs spaced 3½" to 4" used as form for concrete, then plastered underneath with 1:2 portland cement mortar
Longitudinal reinforcement
TYPICAL SECTION OF STEPS
CONCRETE MIXTURES:
1:2:4 for slabs, beams & girders
1:2:4 for column footings
1:1½:3 for columns.
1:2 for portland cement plaster under seat deck
32"
12"x32 reinforced concrete girder
18'-2"
A
Steps at aisle
12"x14" reinforced concrete strut
12"x32" Reinforced concrete beam
13'-8"
18"
12"
8'-6"
19'-7"
19'-7"
19'-7"
3'-6"
1'-10
7'-0"
2'-0"
3'-0"
4'-0"
1'-2
NOTES: Expansion joint extends through entire structure, including seat deck, at intervals of 50-ft No actual connection between parts of structure in two adjacent sections.
Double girders at all expansion joints. Single girders at intermediate rows of columns.
Actual seating capacity, 620 per 50-ft. section.
TYPICAL CROSS SECTION OF GRAND STAND.
(SHOWING DOUBLE GIRDER CONSTRUCTION AT EXPANSION JOINT)

FIG. 2—DESIGN FOR REINFORCED CONCRETE GRANDSTAND. TAKEN FROM DESIGN OF STAND BUILT IN 1918 BY THE STATE FAIR ASSOCIATION, HURON, S. D.

Derr, State Engineer, Pierre, S. D., and built by W. S. Jonason, of Aberdeen, S. D.

The grandstand has a concrete roof slab supported by a structural steel frame anchored to the reinforced concrete frame of the main structure. All the concrete beams and columns and the deck were cast together. Additional units or sections may be added. Expansion joints, spaced 50 ft. apart, extend completely through the structure, each section comprising a separate unit, free to expand or contract. Rollers set in the expansion joints provide ease of movement. The concrete was deposited on Hy-Rib reinforcing, acting both as forms and reinforcing. The under side of the seat deck was plastered with cement mortar and washed with white cement. This sets off the grandstand in an excellent manner, and makes the rooms underneath very light. Rest rooms and booths are provided under the stand on both sides of the entrance, and in time all this space will be paved with concrete and used for exhibits.

The seats are made of 2-in. x 10-in. planks, attached to metal inserts set in the freshly placed concrete. All steps and the side and back walls are built of concrete.

A special portable chute was used for distributing the concrete along the deck of the grandstand. Concrete was mixed at a central plant and elevated in a tower just back of the center of the stand. On the top, a runway was built for carts to carry the concrete from the tower to the portable chute. This chute was made of 1-in. boards, and extended from the top and rear of the stand to the bottom and front, making a continuous trough about 80 ft. long. Small gates on the side of the chute, when opened, automatically closed the chute at that point and diverted the concrete into the forms. The portable chute was on two tracks about 25 ft. apart. This made it possible for the workmen to move the chute from one end of the stand to the other and deposit concrete wherever it was needed. The overhanging ends of the chute were held up by means of wires running over the top of an arch 5 ft. deep above the chute and over the tracks. This gave the entire device the appearance of a suspension bridge. This portable chute was devised by the contractor and proved very satisfactory, besides being inexpensive to construct. (For details of the chute, see an article in CONCRETE, December, 1918, page 194.)

The forms were sprinkled just before the concrete was placed, after which the forms were left in place and sprinkled frequently for one week. The maximum strength of the concrete was developed in this manner.

Cement Plant Model Made Largely of Cement

BY HENRY W. NICHOLS
ASSISTANT CURATOR OF GEOLOGY
FIELD MUSEUM OF NATURAL HISTORY
CHICAGO

The Field Museum of Natural History has just completed, for the series of models which accompany its collections illustrating economic geology, a large model of a cement plant. Many of those associated with the cement industry have already had an opportunity to inspect this model for it was exhibited at the Drake Hotel, Chicago, during the meeting there of the American Concrete Institute.

This model, 12 ft. long and 3 ft. 6 in. wide is built of reinforced concrete. (The Museum now does many models in cement and concrete as more satisfactorily worked and more durable than plaster). The cement plant model reproduces with fidelity to minute detail an existing plant and in fact was built from blue prints of the plans used in constructing the actual plant. It is of the realistic type of model, that is, the model is intended to be a miniature reproduction of the plant and its surroundings in looks as well as design.

The only exception is that those buildings which house important machinery are skeletonized. The structural steel framework of these buildings is reproduced without the sheathing so that the interior is visible. Also in many of the buildings where the heavy framework obscured too much the view of the interior, much of the framework has been omitted. Also one unit of most of the machines is shown in section.

Certain considerations made it seem desirable to provide a more elaborate model that might seem sufficient. It was believed that the comparatively recent development of the cement industry to a position of major importance has left the public with less full knowledge of the nature of this industry than of the older great industries such as iron smelting. Miscellaneous inquiries confirmed this belief to a surprising degree and it became evident that the model must show not only how cement is made but something of the magnitude and complexity of the plant required. The hearty and efficient cooperation of the officials of

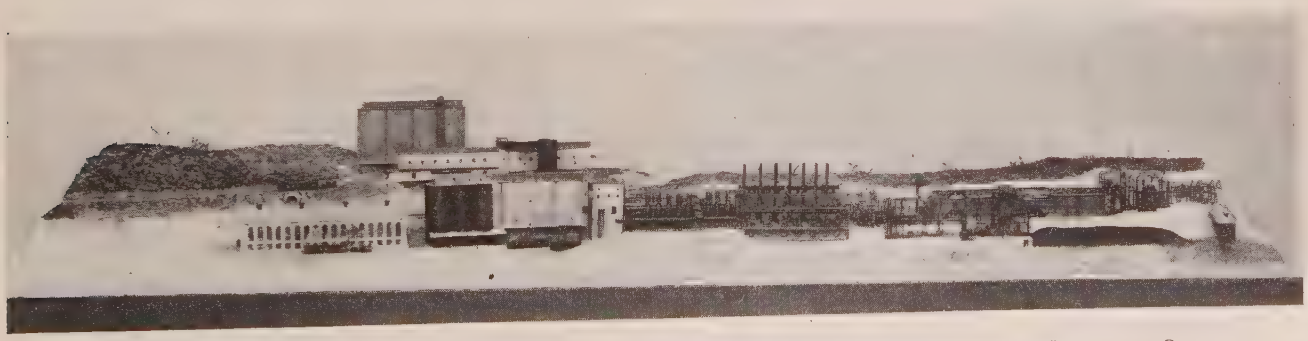


FIG. 1—COMPLETED MODEL OF MODERN CEMENT PLANT. A SECTION OF THE MODEL SHOWS HOW THE RAW MATERIAL IS OBTAINED

Figs. 2 and 3—Field Museum's Model Makers at Work on Cement Plant Model

this plant made the work much easier than it would otherwise have been. They provided complete detail plans and all photographs desired. They facilitated in every way the study of the mill and assisted in every way possible.

The first work was the preparation of a topographic model of the ground. Sections to a scale of twelve and a half feet to the inch were drawn from a topographic map of the plant. These were transferred to pieces of board which were then cut to shape and mounted in a wooden frame. This provided a base with cross sections of the ground contour every six inches. A sheet of expanded metal tacked upon this assumed roughly the form of the surface to be modelled. This form was checked against the topographic map and all minor changes of level were impressed by bending and hammering. The expanded metal was then covered with a thin layer of 1:2 cement and sisal fiber. The cement was mixed rather liquid, the dry fiber was immersed in it and worked by the hands to a thin mat carrying as much cement as it would hold. This was smoothed on the expanded metal. Over this, on portions of the model which were smooth, was laid a finishing coat largely of white cement. Surfaces such as limestone cliffs were given a surface of white cement which was modeled to shape from photographs. Templates of all buildings were drawn to scale and cut from beaver board. Corners of the buildings were located and outlines drawn on the model from the templates. This located all buildings accurately. Plans and elevations of all concrete foundations were drawn from the blue prints and all foundations were modeled in place of 1:4 concrete. The model was then ready for the buildings.

The crusher building was the first reproduced in skeleton form. Each bent of steel was drawn separately

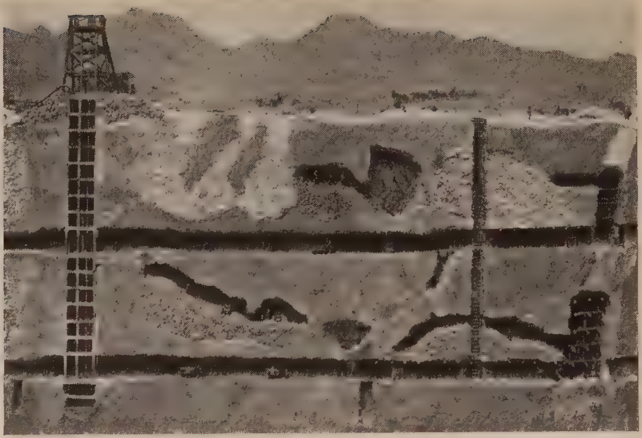


Fig. 4—A Mine Model Showing How Underground Operations Are Carried On

to the scale of the model from blue prints. For the structural steel, narrow strips of copper or tin plate were used. These bent to angle and channel forms readily and from two pieces fastened together I's, T's and H's were readily made. Drawings of the bents were transferred to smooth boards, the structural shapes were cut to size, laid on the drawings and soldered together. Transverse and diagonal members were prepared and the framework assembled by similar methods. Those parts of the machinery which are made up of structural steel and rounds were reproduced in the same way. Other parts such as crushers and grinding mills were in some instances modeled in plastilene and cast in plaster molds from solder, others were carved from wood. Most of the important machines are shown in section as well as whole. Belts are of painted paper and numerous materials and methods are employed for various needed effects. Those buildings which are shown complete with their outer walls presented no special problems. Some are of wood but most of them are made from tin plate. The somewhat unkempt grass is of sisal fiber set directly in the concrete. Shrubs and trees are of dried weeds preserved by paint and given proper form by addition of small masses of white lead where needed. Freight cars, engines and other accessories are of wood except the men which are carved direct from thick sheet lead.

As this company mines its stone and shale, underground workings are shown from the rear face of the model. These are dimly illuminated by artificial light and show the rooms with the miners and shovels and cars at work. This lighting is accomplished by placing a single incandescent lamp in the space below the model and leading the light by a special form of tin reflector to small holes in the floor of each room of the mine.

It was hoped that owing to the straight line form of the plant and the design of the reproduction, visitors would be able to follow processes as readily as they could with a simpler model, while the size and complexity give the proper impression of the magnitude of the industry.

Accompanying pictures show the completed model and two of the Museum's expert model makers at work upon it several months ago.

The May issue of Concrete will be of unusual interest and importance to the more progressive element among manufacturers of concrete building units.

Graded Aggregate:

News, Review, Hearsay, Comment—A Department of Fragmentary Miscellanies—the material for which will be gathered from the job, the office, the factory, over the lunch table, in Pullman smokers, from the morning mail and many other sources.

Free Lime in Concrete Reacts With Paint Oil

When paint or varnish having a linseed oil base is applied to an untreated surface of fresh concrete it is likely that free lime or other caustic material in the concrete will react with the oil of the paint and cause disintegration and failure of the paint. To prevent such action the surface of the concrete should be treated with a thorough coating of zinc sulphate solution prepared by dissolving three pounds of zinc sulphate crystals in a gallon of water. The solution may be applied with a brush, spray, or in the case of small units, by dipping. This treatment will neutralize any caustic material in the concrete and after it has dried thoroughly (about 24 hours) the paint or varnish may be applied.

* * *

A "Secret Process"

The following interesting story of the experiences of a pioneer use of cement was told recently by Dr. J. M. Williamson of Moundsville, W. Va.

Dr. Williamson is a dentist, familiar with chemistry and its allied scientific branches; a progressive citizen; is mayor of Moundsville now and has served in this capacity at different times for several terms. Back in the older days of Moundsville all the sidewalks were built of brick or stone slabs, concrete never having been used for this purpose and had only been heard of in the larger cities. The Doctor had built a new house and as a progressive citizen, having heard of the use of cement in concrete sidewalks decided to use this material for the walks around his place.

Knowledge of the proper use of cement was not as common then as now so he decided to secure a barrel of cement and do a little experimenting. This cement was secured in Wheeling and in his laboratory the Doctor mixed up a great many samples of different proportions and consistency until finally he found a mixture which promised the best results. The data gathered from these trials showed that after all the making of concrete was a simple matter, and Dr. Williamson decided to back the business of contracting to build sidewalks for others. The question of competition arose since the mixing and placing of concrete was so easily done as to invite others into the same business.

In order to capitalize his knowledge and prevent competition he decided upon a ruse which would mystify onlookers. For this purpose he prepared a saturated solution of permanganate of potash and gave his foreman instructions to use a definite amount of this solution in every bucket of the mixing water which turned it red. The inference of spectators was that this unknown chemical was a prime ingredient and red water was absolutely necessary for concrete.

Dr. Williamson says that this foreman forgot his instructions in one batch of concrete mixed before a large audience and, not wishing to waste the cement used, asked the Doctor what to do. He was instructed to throw the batch away, mixing a new one with the mysterious red water. This act led the spectators to a more firm belief in the virtues of the mysterious chemical and resulted in a prolongation of the monopoly until newcomers with a wider knowledge showed that plain water was as effective as any other. From then on the monopoly broken, the use of red water was abandoned, but not until a large amount had been placed by this "secret process." Not infrequently the "secret part" of a secret process serves no more important purpose than to make the job look harder.

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Greater Chicago Concrete Products Association Builds Show House

The Greater Chicago Concrete Products Association built a concrete masonry and portland cement stucco house as the center of attraction at the Own Your Home Exposition held in the Coliseum, Chicago, March 22 to March 29, in addition to booths of an educational nature. The total cost of the exhibit is in the neighborhood of $7300, of which the products men raised nearly half and the cement industry the remainder. Jacob Bosch is president of the G. C. C. P. A. and W. D. M. Allan, secretary.

* * *

Stucco to Imitate Travertine

An effective imitation of Travertine stone is produced with portland cement stucco as follows, according to a correspondent of CONCRETE:

The scratch and second coats of stucco are put on as for other stucco work using mixes and methods recommended by the American Concrete Institute.

Before applying the third coat, the second coat is sprinkled to "kill' part of the suction. The finish coat is then applied and while it is still in the plastic condition the surface is stippled with a sponge or very coarse brush to pull up an irregular texture on the surface of the mortar. The coat is then lightly troweled, smoothing down the higher portions of the top coat to a plain surface, but still leaving some of the irregular indentations caused by the previous application of the sponge or brush used for stippling.

It goes without saying that the mechanic has to use considerable good judgment in regard to the location, spacing and arrangement of his stippled areas or instead of getting a Travertine stone effect he will get a job that is highly artificial and unpleasant in appearance.

Nearly all plaster contractors, however, have some men in their organization who have some artistic sense and a degree of real craftsmanship, who do this type of work, once they understand the effect sought.

Sodium Silicate as a Concrete Hardener

Progress made in the United States in the treatment of concrete roads with silicate of soda is referred to in *Chemistry and Industry* as an important factor in reducing the cost of upkeep of roads. According to the article from which the following is abstracted, silicate of soda is a complex mixture made by fusing together a good grade of sand with soda ash and is supplied in a considerable number of different grades or ratios, all of which are completely soluble in water depending on the relative amounts of sand and soda used, the ratio figure being expressed as the number of molecules of silica (SiO^2) per molecule of soda (Na^2O).

An example of a very commonly used silicate is 2.0 molecules of silica, in the form of a thick liquid, the composition being 27.61% SiO^2, 14.19% Na^2O, and 58.20% water. All the various grades of silicate are generally sold in the liquid state, popularly known as soluble glass or water glass, but may also be obtained as soluble powders and in lump form.

When a very dilute solution of silicate of soda, which must, however, be of the correct ratio to give the proper results, is applied to the surface of concrete, the solution penetrates to a depth depending on the condition and the original method of laying of the concrete. All concrete, no matter how carefully mixed, contains microscopic pores, but in practice, considerable differences are shown in this respect. The result of the penetration is the formation of an intensely hard and dense outer skin or layer, which is much more resistant to abrasion and general wear and tear than ordinary untreated concrete, whilst being also more proof to water and oil and almost entirely dustless, without becoming slippery. The reaction that results when a very dilute solution which must contain about 1 part of the commercial silicate of soda to 4 parts of water, is allowed to soak into concrete, appears to consist chiefly of a combination of the soluble silicate of soda with free calcium hydrate always present in the concrete (being liberated in the setting of the cement) to give a hard, insoluble calcium silicate which completely fills up all the pores.

* * *

Portland Cement Association Staff Changes

C. D. Franks who since June 1916 has been district engineer in charge of the Association's Indianapolis office is appointed assistant general manager in administrative charge of Association work in the districts covered by the Minneapolis, Milwaukee, Des Moines, Chicago, St. Louis and Indianapolis offices. Until June 1, 1924, Mr. Franks' headquarters will be the Merchants Bank Building, Indianapolis. After that date his headquarters will be 111 West Washington Street, Chicago.

L. C. Miller succeeds Mr. Franks as District Engineer in charge of the Indianapolis office. Since February 1917, Mr. Miller has been Association field engineer in Indiana and during his work in that capacity has acquired a large acquaintanceship in the district of which he now takes charge. The Indianapolis office of the Association, located in the Merchants Bank Building, is in charge of the Association work in Indiana and Kentucky.

A new Association office is open in Charlotte, North Carolina. John E. Tate, heretofore district engineer in charge of the New Orelans office and previously Association field engineer in North Carolina, is appointed district engineer in charge. Until July 1 this office will be located in the Piedmont Building. After that date the permanent address will be the Johnston Building. The Charlotte office will be in charge of Association work in North Carolina.

Leslie H. Allen Assumes New Responsibilities

Leslie H. Allen, formerly with the Portland Cement Association as assistnat manager of the Concrete House Division, and recently associated with Russell Barr Williamson, Milwaukee, Wis., in a general architectural practice, has become general manager of the Concrete Tile Machinery Co., and the Hawthorne Roofing Tile Co., Cicero, Ill. Mr. Allen was educated in the London Colleges of civil engineering and architecture, of which he is a graduate, and has gained wide experience in England and the United States practicing architecture and structural engineering.

Prior to his connection with the Portland Cement Association, Mr. Allen had direct charge of the concrete housing activities of the Aberthaw Construction Co., Boston, and the Fred T. Ley & Company, Springfield, Mass., superintending the erection of several hundred concrete houses as well as many of other materials. Mr. Allen's past training and experience, including that with the Portland Cement Association, where he was in charge of housing, roofing products and similar promotions, will be of particular value in connection with his present position.

The Concrete Tile Machinery Co. and the Hawthorne Roofing Co. are entering upon a greatly enlarged scope of activities. The Hawthorne tile machine is to be offered to progressive manufacturers in every locality large enough to support a thriving business. Important extensions are under way at the company's main plant to meet the demands of the rapidly growing Chicago and suburban market. A big year is looked for in the roofing tile industry, not only in the vicinity of the factory but throughout America.

* * *

Minimum Live Load Requirements for Use in Design of Buildings

A tentative report has been issued by the Building Code Committee of the Department of Commerce on floor load requirements. The report which is strictly tentative in nature is based upon the best information the committee had been able to obtain and is issued for criticism and discussion for those interested in the improvement of building codes and competent to discuss the recommendations.

The report is divided into three parts. The introduction includes a brief description of the organization and procedure of the Building Code Committee. Part 2 gives recommended limitations for safe loads as the basis of design. These are briefly stated in the form of recommendations suitable for municipal adoption. In part 3, the appendix, is included a statement of the data and reasoning upon which the recommendations in part 2 are based. An analysis of building code requirement of 109 representative cities of the United States giving the minimum floor load requirement allowed as a basis of structural design is included and the committee is desirous of obtaining additional floor load data for inclusion in the appendix.

* * *

"Dope" for Mold Coating

"Cast stone and concrete unit makers may be glad to try as mold surfacing what is known in this country as 'Dope'," writes Charles Marques, architect and engineer, Brunsdown, Middlesex, England. "It is actually liquid celluloid sold as cellulose and is used principally for waterproofing airplane fabrics. The writer has used it with varying success on plaster and wood molds. The facings leave it as freely as from glass. Green timber should have a wash of methylated spirit to evaporate the surface moisture before applying the Dope. It provides a fine impermeable and pore filling surface but has the disadvantage of shrinking out of angles when applied thickly. A mixture of this with common whitning made stiff will fill cracks or joints and become as hard as celluloid."

* * *

A Highly Colored Igneous Rock Deposit

Mineral aggregates of good color value are in increasing demand for stucco finish, terrazzo and ornamental concrete in general. Arthur B. Call, Pasadena, Calif., is developing a tract which contains about 2000 acres, in Mint Canyon, South of Palmdale, about 60 miles from Los Angeles. The tract contains igneous rock in green, pink, red, black, silver, lavender, and of pink and green mottled, the tones of all exceedingly clear and vivid.

So far the depth of the deposit has not been ascertained, but the extent is so great that the supply is practically inexhaustible. Visiting geologists declare that nothing approaching it in quality or purity of coloring has ever been discovered, writes a correspondent of CONCRETE.

The work of quarrying and crushing has been under way for a year, and to demonstrate the new material the company controlling the output has put the stone in terrazzo in the floors of several new public buildings in Pasadena where it has attracted great attention. They have confined their efforts to this terrazzo work, crushing the rock to the desired grading. The result has been that of an exquisite vari-colored marble. A bathroom just completed in a private home has floor and walls of a lavender stone.

As a surface material for roofing, the rock enters upon another vast field. So far the company is busy evolving decorative stone-work, such as fancy copings, tiles, pillars, mantels, bricks and the like to meet architects' whimsical calls without varying the color schemes of the structures. In all, sixteen different types of rock are found in this one rich tract.

* * *

Open Air Road Congress

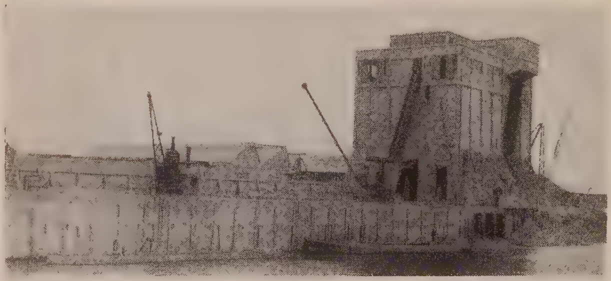
The first open air demonstration of road building methods and machinery will take place in North Carolina June 4, 5, 6 and 7. The American Road Builders' Association has accepted the invitation of the North Carolina State Highway Commission to hold such a demonstration or "shirt sleeve road show" as it has been christened by Frank Page, president of the American Road Builders' Association. The Pan-American Highway Commission, consisting of a group of about forty leaders in the highway movement in the various countries of South and Central America, will be in North Carolina at that time. These distinguished visitors will visit the shirt sleeve show, and the American Road Builders' Association accepted the invitation of the North Carolina State Highway Commission in order that it might do its full share to assist the members of the Pan-American Highway Commission in their study of highway conditions in the United States.

Hitherto, all exhibits of road building machinery in the United States have been held indoors where it was impossible to put the machinery actually at work. For this reason the North Carolina show will be of unusual interest. The Pan-American Highway Commission, as well as engineers from other foreign countries who may be in the United States at that time, will have an opportunity to see the latest types of machinery in operation under ordinary working conditions.

Engish Gravel Plant Manufactures Concrete Products

The Trent Concrete Co., Ltd., has anticipated a big concrete era in England, and has just completed a large crushing mill for the preparation of concrete aggregates. To create an extra outlet for the products of the gravel and sand mill, there is a subsidiary plant for the manufacture of all classes of precast concrete products in plain and finished castings, fence posts, clothesline posts, lawn tennis posts, rose and vine posts, garden edging, paving slabs, slabs for gas stoves and gas rings, manhole covers, lamp posts, electric power standards, piles, copings, roof tiles, lintels, sills, steps, door hoods, and concrete products for farm use.

The whole of the crushing mill, including the rough gravel silo, bunkers and water tank is of reinforced concrete. The mill is divided into four complete units, each unit being capable of dealing with 16 tons of gravel per hour. The working of the mill is based upon gravitation and railroad cars, road vehicles and barges can be loaded at the rate of about 10 tons per min. by the opening of large chutes at each side and directly under the middle of the building. The rough ballast arrives alongside the river wall, and is lifted from the barges by traveling cranes and dumped into storage, as shown in the accompanying illustration.



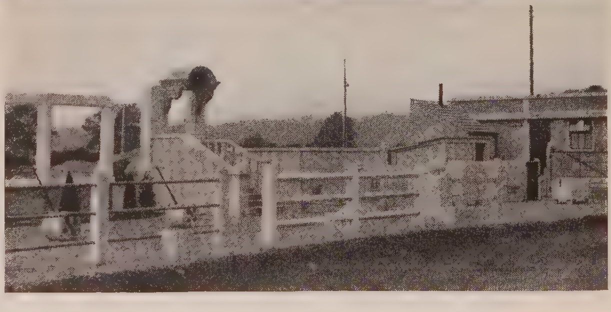


FIG. 1—THE REINFORCED CONCRETE STORAGE HOPPER AND WASHING MILL OF THE TRENT CONCRETE, LTD., COLWICK, NOTTINGHAM, ENGLAND

FIG. 2—THE CONCRETE PRODUCTS PLANT OF TRENT CONCRETE LTD. AND SOME OF THE PRECAST CONCRETE PRODUCTS MANUFACTURED AS A MEANS FOR DISPOSING OF SOME OF THE PRODUCTS OF THE GRAVEL AND SAND MILL

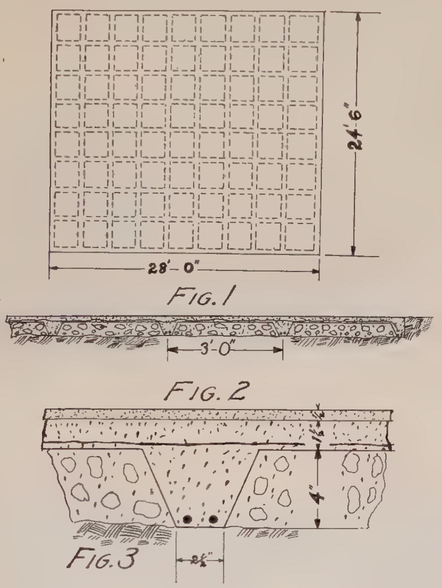
The material is released through hopper gates on to a large trough conveyor, and is carried to the boot of an elevator which lifts it 70 ft. to washers which thoroughly remove all the dirt. The clean sand is elevated out of the washer, and is delivered direct to a storage bunker. The gravel is passed on to a grader which divided the material, over 1 in. to go to crushers and under 1 in. to the rolls. After being crushed, the material falls onto belts discharging onto a second group of washers, and the material is finally washed and divides by revolving screens into measures from ⅛ in. to ¾ in. The water for washing comes from a 50,000 gal. reinforced concrete water tank. The output in excess of the bunker capacity is carried by runway and dumped into rectangular piles along the standard gage tracks, so that loading can be speedily effected with a traveling crane.

Three Kinks:

Floors and Sidewalks—Walls and Chimneys

By H. H. Siegele

A number of years ago I saw a man taking up a concrete sidewalk that apparently had been in place for years, and yet it was without a crack or defect of any kind. Evidently the builder of the sidewalk had been short on material, and being in a hurry to get the job done, had filled up a large part of the center of the walk with cinders in such a manner that it left a sort of beam on each side. The side beams were connected with a 2-in. slab, which was run over the cinders. A short time after that I had some walks of my own to build, and some cellar floors to put in. Benefitting by the observations related above, I figured out a kind of beam construction for building my walks and cellar floors.

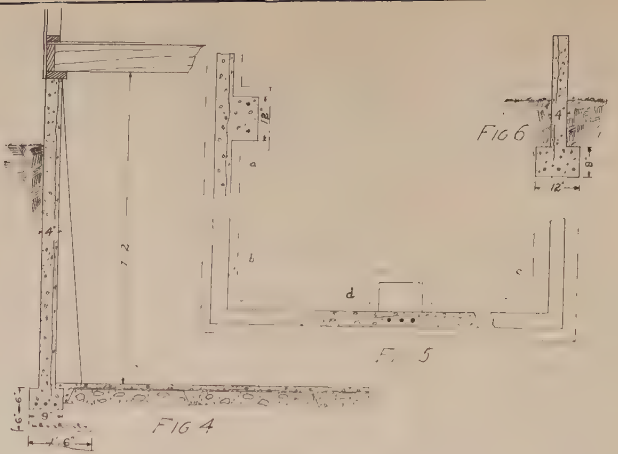


Figs. 1 to 3—Details of Special Floor Construction

Fig. 1 shows a section of concrete floor—the dotted lines indicating the network of reinforced beams that support the 2-in. slab over the top. In this instance the beams are placed 3 ft. from center to center. The spacing of the beams, of course, must ge governed by the kind of traffic that the floor or walk will be subjected to. If the traffic is very light, 4 ft. from center to center will give good service. Fig. 2 shows a sectional view of the construction. The heavy dots near the bottom of the beams indicate pencil-rods, while the irregular line near the bottom of the 2-in. slab indicates the reinforcement for the slab. This consists of woven wire fencing.

The space between beams is filled in with cinders. In order to do this, a section of form as large as can easily be handled should be made, having the shape of the beams. This form is placed into position and spaces filled up with cinders. When the cinders have been packed, the form is lifted out and set for the next section. This operation is repeated until all the cinders are in place. After the reinforcing is laid the forms are ready for the concrete. Fig. 3 shows the construction in detail.

My own experience proved that 50% of the labor and material can be saved by this method of building concrete walks and floors. And at the same time better results are obtained than by the old way of building a thick slab without reinforcement—the weight of which often causes its own destruction.



Figs. 4 to 6—Reinforced Concrete Wall and Pilaster for Basement Construction

Thin Reinforced Walls for Basements

If a 4-in. slab of reinforced concrete will hold up its own weight, together with a live load, such as corridors of public buildings, at times, are subjected to, why should not a 4-in. reinforced concrete curtain-wall be sufficient to retain the dirt for a basement, and support the superstruture of a one-story building?

This question arose a few years ago, after I had seen a slab 4 in. thick put in to support a corridor floor of a public building.

After that I built a house of my own, in which I used a construction for the cellar walls similar to that illustrated in Figs. 4 to 7. These walls have been in for over two years and are still without a crack.

Fig. 4 shows a cross section of the wall and footings and the battered pilaster, the footing for which is shown by dotted lines. This footing is reinforced with six short bars—three each way, indicated with dotted lines near the bottom. The wall is reinforced with woven-wire fencing, the location of which is shown by the irregular line. The pilasters should be spaced about 10 ft. from center to center. The pilasters and the curtain-walls should be poured simultaneously.

Fig. 5 (a) gives a plan of the pilaster and the wall in part, showing the location of the reinforcing of the pilaster as well as the wall. The location of the reinforcing at the top of the pilaster and wall is shown in

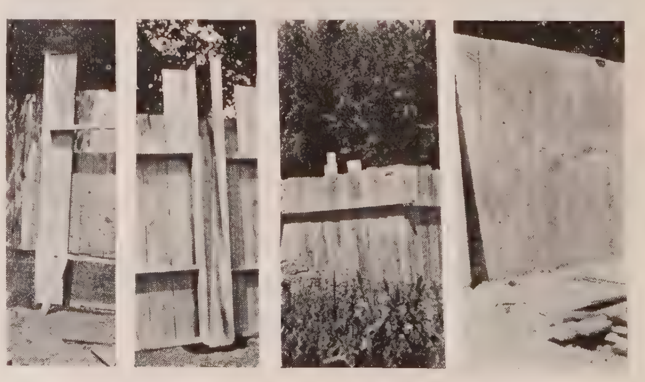
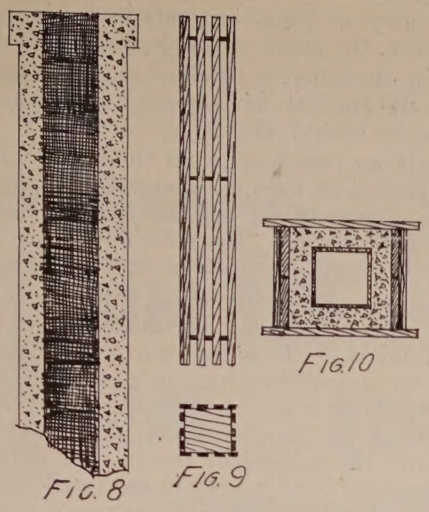


Fig. 7—Left to Right—Outside Forms, Reinforcing and Partially Completed Inner Forms—Completed Forms for the Wall and Pilaster—Outer View Showing Corner Construction After Concrete Was Poured—Curtain Wall After the Forms Were Removed Showing Pilaster at Extreme Left



FIGURES 8 TO 10—DETAILS OF FORMS FOR CONCRETE CHIMNEYS

section (d). Section (b) shows a plan of the corner of the cellar wall, and (c) shows a corner-plan of a simple foundation wall, such as is shown in cross-section by Fig. 6.

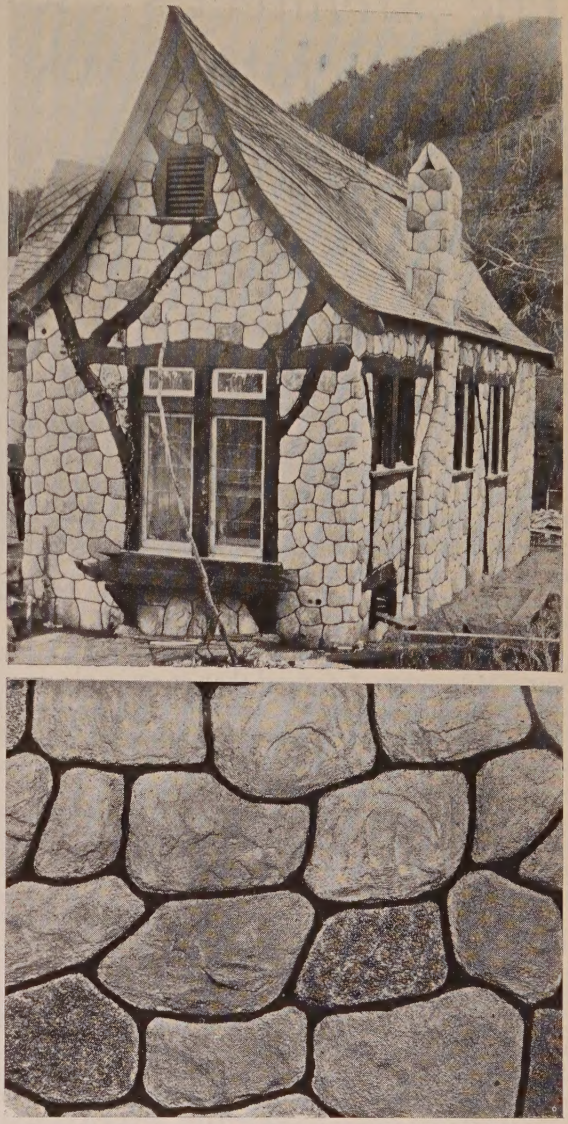
The object of this method of constructing cellar and foundation walls is to save labor and material. If good material is used there is no question about such a wall carrying any kind of one-story frame superstructure. For heavier buildings the walls and the pilasters should be increased to meet the additional load.

TO PREVENT CRACKS IN CONCRETE CHIMNEYS

I have had more or less expereince with form building for concrete chimneys. I have seen many chimneys constructed of concrete up to the first floor line, and some made entirely of concrete. Almost invariably when the flue was formed with boards, the swelling of the boards cracked the walls of the flue, sometimes from the top to the bottom; thus making the chimney defective from the very beginning.

I have found two remedies for this difficulty, both of which are very simple and satisfactory. Figs. 8 and 9 illustrate the most inexpensive form for a flue that can be constructed, and one that will never crack the concrete while it is still green. The skeleton form shown by Fig. 9, is made as follows: Cut three ½-in. spreader-boards ½-in. smaller than the size of the flue, then take some common laths and nail them onto the spreader-boards as shown. Cover this skeleton form with burlap or good building paper, and one section of the form is ready for use. Make as many sections as are needed to complete the flue. As soon as the concrete has had the initial set, the spreader-boards should be punched out, and the rest of the form will come off easily. Fig. 8 shows a sction of a flue before the forms have been removed.

Fig. 10 shows the cheapest way to form the outside of a concrete chimney, running the boards up and down, holding them together with cleats, on two opposite sides and on the other two sides nailing short boards horizontally. These boards I usually nail on just as the concrete is being poured. This figure also shows the other method, mentioned above, of preventing the flue forms from cracking the walls of the chimney. This method is a little more expensive but it makes a thoroughly fireproof job. Simply use flue lining for the inside forms and set the sections in place just as the concrete is being poured.



Where Is That Lemon Pie?

This is another of those "imitations" which concrete is heir to. It goes to show what a man *can* do if he gives his mind to it.

Probably the builder had a good laugh too. Where? Why, near Los Angeles. The builder makes a specialty of artistic stucco. That's what this is—the man who sent us the picture said so.

"The work is very simple," we are told. "The walls of the house are two coated as in ordinary stucco; the stone blocks being marked out, and the grooves scratched in, with a pointing trowel, before the second mortar coat is set. The blocks are made to bulge in the center, and a few irregular trowel cuts or dabs of mortar are added, here and there, to the blocks, to help out the rock effect sought.

"The whole wall surface is brushed with a whisk-broom when the cement is but partly set. The joints of this particular structure were painted with dry brown color mixed in nothing but water—a little cement or a mordant would probably have helped, if added, to fix the color. Ground granite was dashed on a few of the blocks to secure variety."

CONCRETE is still in search of a concrete lemon pie.

The Architect's View of Concrete Block

From an address by H. J. Rotier, Sec'y. Architects' Small House Service Bureau North Central Division, at Convention of Wisconsin Concrete Products Association.

It was back in 1907 and 1908 when I had my first opportunity to use concrete blocks in a house above the basement. I built two dwellings at that time with concrete blocks, from foundation to roof, and all of the plain face, laid up in regular courses.

These houses stand today in aristocratic neighborhoods, and, after 16 years, hold their heads up as high as the most modern. These homes were a success from a practical standpoint; they are dry and comfortable in the severest weather, and have proved a good investment for the occupants, and have required comparatively little fuel to keep them warm.

But something more than this is necessary to sell the idea of the general use of block; by that I mean the employment of the concrete block in the same promiscuous way as the clay brick.

In a visit one day to several concrete block factories around Milwaukee, I noticed that at some places some plain blocks had a finer and smoother appearance than others in the same yard, and, in addition to that, there was a slight touch of color mottling on the surface. As these were piled up among the others, no doubt they were carted to the job and buried with the others in the ground. Upon inquiry, they told me it just happened that way, and that it was perhaps due to the sand used.

Now, I believe right there is an opening for study, with the opportunity of producing a plain smooth-face block *having a trace of color*, with little or no additional cost.

This slight mottling or trace of color is just enough to place that kind of block in a class by itself, and when laid up, say in random courses with a neat beaded joint, it will prove an interesting wall.

Mentioning random courses. Here is another method of getting away from the dull monotony of the regular courses, and the somber gray effect, and changing the work into an interesting architectural feature.

Most block machines will turn out half courses as well as full courses. Take the standard block, 8 in., 10 in. or 12 in. thick by 16 in. long and 8 in. high, and half blocks together with half courses, and their half blocks; this will give wall surface units 16 in. x 8 in., 8 in. x 8 in., 16 in. x 4 in. and 8 in. x 4 in., these, with an occasional 4 in. x 4 in., give five different units, and can be laid up at random, breaking the horizontal or bed joints about every 4 ft. This it is that will give life and interest to such a piece of masonry.

Give the architect such units and such color blends, and he will produce a home of concrete that the public will buy in preference to many others.

When I speak of color, I do not refer to the colors of certain kinds of concrete brick produced. These colors, by the way, are very fine, and I have wondered why they are not applied to block; but what I mean is a kind of color that may be called only a suggestion of a tint, and which may be found in all good grades of sand.

I am talking to you about concrete block because:

First: It is a building unit that is fireproof.

Second: A block can be produced and laid in the wall for less money than any like material.

Third: It can be made to look as well as brick or stone, if properly handled.

Now, because of these intrinsic values, it is shortly going to play an important part in the building of the small house, the home of the democracy of America.

I see in the concrete block of today, a great future, and by its gradual development blossom forth into "A thing of beauty and a joy forever."

There is no reason why all the colors of sand and pebbles cannot be reflected on its surface, and make as beautiful a piece of masonry as produced by the well-known field granite. Its possibilities are unlimited, and a fortune will be made in its production.

Such a concrete block house will be an interesting home, because there will be no deception; there will be no camouflage. It will appear to be just what it is, and not try to look like rock face stone, or some other imitation. That is one of the reasons why I believe in the future of the plain concrete block, and because it will fit into the scheme of things that pertain to the small home and be of benefit to the small home builder.

Two years ago I organized the North Central Division of The Architects' Small House Service Bureau of the United States; our division, with headquarters in Milwaukee, covers all of Wisconsin, the peninsula, Illinois, Iowa and Nebraska.

This national movement of architectural forces is keen for building materials that are durable, economical, and that can be assembled to give good architectural merits, and I see in the plain block great possibilities in that direction.

As business men you have no doubt found out that selling an idea to the public means constant publicity, and I can think of no better way to reach that goal than through the publicity channels of the Architects' Small House Service Bureau.

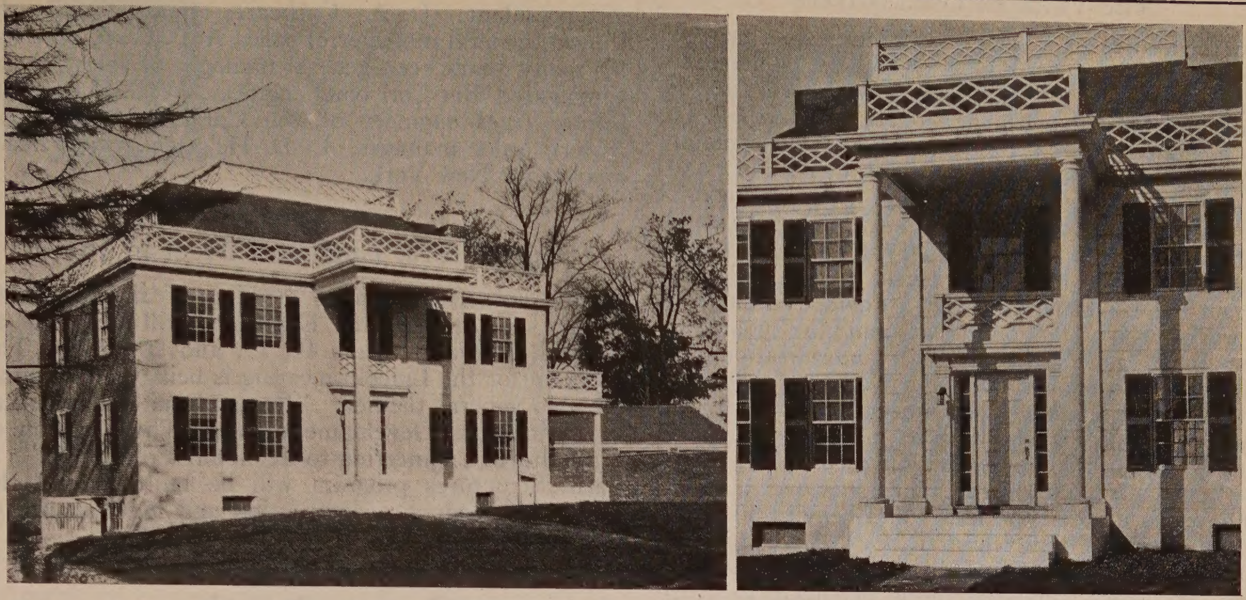
This national organization reaches already from coast to coast, and from Canada to the gulf; the leading newspapers and magazines of this country publish its designs of homes of wood, brick and stucco; then *why not of concrete block.*

Let the architects of the North Central Division design a number of suitable small homes of concrete block, and make them models of their kind. These designs will find their way into all the big circulating magazines and newspapers of the country as Bureau work, and bring the fact before an intelligent building public, the practical economy and pleasing effect of the once-humble and much-abused concrete block.

The value of such publicity cannot be overestimated by your association.

The result will prove a revelation to the masses, and the use of the block for this purpose will increase 300%.

An Interesting House in Holland, Michigan, Built of Concrete Masonry—Duntile and Stucco



House in Belmont, Mass., Built of Concrete by Bates & Wigglesworth, to Look Like Wood

Concrete House Looks Like Wood

Many readers of Concrete will remember the interesting house built for Victor H. Wigglesworth by Bates & Wigglesworth Co., Belmont, Mass. Using a system of wood forms and with painstaking detail in every part of the workmanship, a New England colonial farm house was erected in every detail simulating wood structure of 150 years ago.

The accompanying illustration shows another house, wood in effect but not in fact, designed by Mr Wigglesworth and built by Bates & Wigglesworth on Slade Street, Belmont. Even the lacy balustrade is of reinforced concrete. Simple V joints effect a detail so common in many fine wooden houses of many years ago.

Astoria Apartments of Concrete

The construction of the Astoria apartments by the Crescent Development Co., New York City, in that part of Astoria, L. I. which is adjacent to the Hoyt Avenue station of the Astoria subway, was described in the December issue of Concrete. The entire plot to be developed covers six blocks and the contract under way at the time the article was published involves 51 or 150 buildings.

Since concrete apartment houses of this type are not by any means common, especially when finished in the rough and with an almost medieval suggestion in the architecture, the literature used by the Crescent Development Co. from its renting offices is especially interesting to concrete house builders. The accompanying illustration is from a circular used by the rental agency. The whole development is called Crystal Gardens. Crystal Gardens is but fifteen minutes travel from the heart of New York City. Following is part of the rental agency descriptive matter:

Crystal Gardens

These apartment buildings have been planned and designed by Messrs. George and Edward Blum who selected as the style best adapted to carrying out the combination of beauty and utility in the exterior design, that type of architecture found in the rural district of Northern Italy.

On account of the extensiveness of this development we have been able to select the finest and strongest of building materials known to modern ages—reinforced concrete.

In creating Crystal Gardens, we have eliminated the interior courts, always a source of discomfort and annoyance in the past, so that every window faces the open.

Unique and individual features include the care taken to depart from the commonplace. The doorways of each building have been treated individually and an artistic effect has resulted.

In all first class apartments today the advantage of having corner exposures is recognized, and in this development each apartment is a corner apartment and has at least three exposures which means it has an abundance of sunshine whenever the sun is shining.

Each house has eight apartments laid out in suites of 4, 5, and 6 rooms with bath and with plenty of large closets. One room in each of these apartments is the corner sun-parlor (a real porch), so arranged that it may be used as a bedroom or living room.

Crystal Gardens

The Value of Used Mixers

In the course of a series of Chicago meetings last summer sponsored by a joint committee of manufacturers and contractors and whose chairman was C. E. Bement of the Novo Engine Co., R. C. Marshall, Jr., general manager of the Associated General Contractors of America, outlined to a small group the need of establishing in some way a value on used contractors' equipment. As an outcome it is interesting that the Marsh-Capron Co., since January 1, 1924, has been issuing a certificate of guarantee. The certificates contain the usual guarantee against defective materials or workmanship for one year and the guarantee implied by participation in the standardization proceedings; in addition a five year drum guarantee and establishing as a further guarantee a definite minimum value on any used Marsh-Capron mixer over a period of three years. Definite rebuilding costs are established on the small and lighter machines over a period of five years, and on the larger and heavier machines over a period of ten years. R. C. Weller, president of the company, points out with regard to trade-in value, on which time has been extended to three years, that this time might possibly have been extended further, but "we are sailing uncharted seas and must proceed slowly."

There is a very substantial shrinkage in the value of a machine immediately after it is used, due to payment of the distributor's commission, the cash discount, the advertising, sales expense and profit of the manufacturer and the physical depreciation of the machine itself. An examination of records running over a period of eleven years leads Mr. Weller to believe that the physical depreciation per year on a 3½-S, 5-S or 7-S mixer runs from 15% to 20%, whereas the total depreciation the first year including the items mentioned, runs from 55% to 80%. On the larger machines, that is, the 14-S, 21-S and 28-S, the indication is that the physical depreciation runs from 10% to 15% per year, while the total depreciation the first year runs from 45% to 70%.

Kalman Steel Buys Corrugated Bar

The Kalman Steel Co., Chicago announces its purchase of the Corrugated Bar Co., Buffalo. The combined companies will be operated under the name of the Kalman Steel Co. with a capital of approximately two million dollars. Possession of the Corrugated Bar Co. plants is taken at once by the Kalman Steel Co. and necessary reorganization looking to actual operation of the Corrugated Bar Co. by the Kalman Steel Co. is to be accomplished shortly.

The Corrugated Bar Co. has been a conspicuous factor in reinforced concrete development since its organization in 1892 and is widely and favorably known for its products, chiefly the Corrugated bar. Its plants are located at Buffalo, Hammond, Ind., Boston, Philadelphia and Atlanta.

The Kalman Steel Co. since 1901 has been continuously active as a distributor of reinforcing steel and related products with plants at Chicago, New York, Youngstown, St. Paul, and Minneapolis. The executive personnel of the enlarged Kalman Steel Co. is as follows: President, Paul J. Kalman, who has headed the Kalman Steel Co. since its inception. Mr. Kalman is also president of Bliss & Laughlin, Inc. of Harvey, Ill., cold drawn steel; president of the Hudson Motor Co. of Illinois; chairman of the board of directors of the Globe Steel Tubes Co., Milwaukee; president of the Kalman Floor Co.; vice president and general manager, George E. Routh, Jr., who, with Mr. Kalman, founded the Kalman Steel Co.; assistant vice president: J. A. Cathcart; treasurer: A. E. Pinard; general manager of sales, A. P. Clark who has for many years been general manager of sales for the Corrugated Bar Co.; chief engineer, W. S. Thompson, former chief engineer of the Corrugated Bar Co.; eastern sales manager, L. O. Helgeson, with headquarters at New York.

Agricultural Engineers Meet in June

The eighteenth annual meeting of the American Society of Agricultural Engineers will be held at Lincoln, Nebraska, June 18, 19, and 20, 1924. The program for the Lincoln meeting is being built around the two general themes: "Research as Fundamental to Agricultural Development" and "The Relation of Agricultural Engineering to Economic Production." A Farm Structures program will be built around the subject of economic construction and maintenance of farm buildings.

Organizations

American Concrete Institute; Harvey Whipple, Secretary 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, Genera Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.